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Identifiers-*Guilford Structure of Intellect Model

Guilford's structure of intellect factors and his inherent form content of instructional materials were not confirmed as effective predictors of differences in learning from figural, symbolic, or semantic modes of visual presentation. The feasibility of using this model as an aid in design and production of instructional materials was investigated in three parallel studies. Each study involved a set of materials with either figural, symbolic, or semantic characteristics predominant in its subject matter. For each of the sets, still slide programs with audio tapes were prepared in three forms: figural, symbolic, and semantic. A total of 247 sixth-grade students were randomly assigned to one of the nine treatment groups, and measures of mental ability, verbal ability, and cognitive abilities related to the three intellect factors were obtained for all participants. Performance was assessed by a written posttest. No conclusive interaction between modes of presentation, inherent content of materials, and learner characteristics was noted. Intelligence and achievement scores related positively to performance in all groups. (SS)

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FINAL REPORT
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June 30, 1968

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

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SUMMARY

This study had as its purpose the exploratory investigation of the feasibility of using J. P. Guilford's structure-of-intellect model as a device for the design and production of instructional materials.

Objectives

The study had as its overall objective the determination of the interrelationships among form of visual presentation, content of instructional material, and characteristics of learners. The specific objectives studied were:

1. To determine what effects three forms of visual presentation (figural, symbolic, semantic) of instructional materials will have upon the learning of cognitive information with figural, symbolic, or semantic inherent content characteristics.

2. To determine what relationships, if any, exist in the learning of the information between learners with different figural, symbolic, or semantic intellectual abilities and the form-content characteristics of the materials.

Procedure

Three parallel experiments were conducted, each using visual still slide materials having figural, symbolic, or semantic characteristics inherent in their subject matter content. Each content area was presented in figural, symbolic, or semantic visual form. The resulting nine experimental sound slide set treatments were presented to 247 sixth-grade students randomly assigned to the treatments, and their performance was tested by means of objective verbal tests of cognitive learning. Analysis of the results was made by analysis of variance, t-test comparisons, and correlation analysis.

Results and Conclusions

The results and conclusions are summarized below for the major comparisons and the learner characteristics:

1. The Semantic form of visual presentation, which presented the content in a meaningful printed verbal form, resulted in statistically significant learning superiority over the Figural and Symbolic forms of presentation for one experiment only. No significant differences were found for the other two experiments.

2. Neither the structure-of-intellect factors of Guilford, the sex, the mental ability level, nor the language ability factors of the subject showed significant relationships to the mode of visual presentation used.

3. There was no apparent relationship between the inherency of the content and the nature of the visual presentation modes.

4. Analysis of individual test items showed that significant differences among the three visual treatment groups favored the Semantic mode of visual presentation in 53.5% of the cases.

5. The major reason for the differences in performance among the treatment groups could be attributed to the similarity between the specific content of the visuals and the responses elicited in the test questions.

6. In summary, the feasibility of using the Guilford structure-of-intellect model as a device to guide the design and selection of instructional materials--either in the design of the form of visual presentation, in the attribution of characteristics to the subject matter content, or in the characteristics of the learners--was not confirmed by the results of the study.

CHAPTER I

INTRODUCTION

Fundamental to effective use of educational media is the design of the messages that pass through them. Variations in message design, in combination with available media and known characteristics of learners, create a complex pattern of interacting relationships that calls for research of commensurate complexity. This exploratory study was part of a comprehensive search for invariants in this pattern of relationships. Such stable factors, once identified, will become the empirical basis for the systematic development of principles of message design.

The application of J. P. Guilford's structure-of-intellect model to the design of instructional materials deserves investigation. If his model reliably accounts for the various intellectual abilities of individuals, such abilities being measurable and quantifiable by different test forms, it is possible that some universal principle may be operating that has application to the structure-of-stimulus materials as well as to the structure-of-intellect. Three of the broad classes of information content described by Guilford in his model--figural, symbolic, semantic--appear to show a relationship to certain characteristics of instructional materials. This relationship is strong enough to suggest that some of the dimensions of the Guilford model be probed to discover whether or not it might furnish insights into the more effective design of instructional media, the characteristics of these materials, and characteristics of the learner as related to content and form.

The Problem

This study has as its purpose the exploratory investigation of the feasibility of using J. P. Guilford's structure-of intellect model as a device for the design and production of instructional materials. The study investigated the teaching of cognitive information in three forms of visual presentation (figural, symbolic, or semantic) with materials having three kinds of inherent content characteristics (figural, symbolic, or semantic). The relative effectiveness of these presentation forms and content characteristics were compared, and the appropriateness of each form-content combination was studied in relation to various learner characteristics, including the figural, symbolic, and semantic abilities of individuals.

Specifically, three parallel experiments were conducted, each using visual slide materials having figural, symbolic, or semantic characteristics inherent in their subject matter content. Each content area was presented in figural, symbolic, or semantic form. The resulting nine experimental sound slide set treatments were presented to sixth-grade students, and their performance was tested by means of objective tests of cognitive learning.

The study had as its overall objective the determination of the interrelationships among content of instructional material, form of visual presentation, and characteristics of learners. The specific objectives studied were:

1. To determine what effects three forms of visual presentation (figural, symbolic, semantic) of instructional materials will have upon the learning of cognitive information with figural, symbolic, or semantic inherent content characteristics of the material.

2. To determine what relationships, if any, exist in the learning of materials having figural, symbolic or semantic form-content by learners with different figural, symbolic, or semantic intellectual abilities.

Review of Related Literature

There is a dearth of previous experimental research bearing directly on the major problem being studied. However, some research has been conducted on related aspects of the problem, and it is to this research that the review will be directed.

Form of Visual Presentation

The past research emphasis on the selection of appropriate forms of visual presentation has been directed almost exclusively to comparisons in the effectiveness of different kinds of instructional media--motion picture, still picture, print, etc.--and on the production techniques for building into instructional messages devices to enhance the learning. The research on these variables has been comprehensively reviewed by Hoban and van Ormer (1950), Allen (1960), and Lumsdaine (1963). But little or no research attention has been given to the different types of forms that might be taken by a particular instructional message presented by means of a particular medium. In the case of this study, these forms have been characterized as being either figural, symbolic, or semantic and have been designed to conform to Guilford's model (1967).

Other investigators have categorized the form of media in other ways, but none of these classification schemes has been similar to the Guilford model. Knowlton (1966), in his taxonomy of "visual-iconic

signs," classified pictures as being realistic, analogical, or logical. Realistic pictures represented "some state of affairs of a sort that is visually perceivable either directly or with technological aid . . . provided that the communicator's intent is to make reference to the type of object portrayed." Examples were real-life photographs. Analogical pictures represented "either the phenomenal or nonphenomenal world . . . through the bridge of the (visual) phenomenal world." Examples were some state of affairs that had no tangible existence or was "too small, too large, too distant, too transient to be recorded by aided or unaided eye." Logical pictures were visual representations wherein the elements were "arbitrarily portrayed, while pattern and/or order of connection are isomorphic with the state of affairs represented." Examples were such representations as electrical circuit schematics or highway road maps. Knowlton's classification thus concerns itself only with iconic signs and excludes verbal symbols. Comparing the Knowlton model with the Guilford model, only Knowlton's realistic and Guilford's figural representations appear to be similar.

Conway (1967,1968) utilizing Knowlton's theoretical structure (1964), distinguished two types of sign vehicles--iconic and digital--and illustrated their relationships to auditory and visual sensory modalities. He classified a line drawing of an object as iconic and the printed work of the same object as digital. Ruesch and Kees (1956) suggested a similar categorization. They classified analogic codification as "a series of symbols that in their properties and relations are similar to the thing, idea, or event for which they stand." Digital codification was said to deal with "discrete step intervals." Examples of digital codification given were the numerical system and the phonetic alphabet. Langer (1942) characterized the two stimulus classes as discursive and presentational. The discursive form of stimuli presented their constituents "successively" and was represented by words. The presentational form, or pictures, presented their constituents "simultaneously" so that the "relations determining a visual structure are grasped in one act of vision." Pryluck and Snow (1967) also categorized stimuli into two classes: digital information and analogic information. Digital information consisted of letters, words, numbers and other familiar symbols of an abstract nature occurring in serial form. Analogic information consisted of pictures, gestures, intonations, etc., occurring simultaneously. They further classified the visual analogic channels into nonverbal (the visual components of pictures, including actions, gestures, physical objects, and settings) and into paraverbal (the embellishments and elaborations on the printed words and symbols used in the visual digital channel).

Implicit in all of these classification schemes is a subdivision of stimuli into two classes: the abstract verbal form (called digital or discursive) and the more concrete nonverbal form (called iconic, analogic, or presentational). The verbal form consists of abstract words, numbers or symbols presenting their information successively and serially in discrete steps. On the other hand, the nonverbal form consists of concrete pictures, drawings, and representations presenting information simultaneously.

These classification schemes may be compared to Guilford's structure-of-intellect categorization, which classifies mode of presentation as figural, symbolic, or semantic. Guilford's figural class is practically identical to the nonverbal channels of the other models, and both the symbolic and semantic classes may be treated as verbal in nature. The difference between the classification scheme used in this study and those discussed above appears to be the addition of a semantic--or "meaning"--element to the verbal category. This may be implicit in the other models, but Guilford makes it more explicit as a special presentational mode.

Content Inherency Characteristics

The application of Guilford's classification of content--figural, symbolic, semantic--to the subject matter content used in this study assumes that the content itself has describable characteristics. There is, however, no available "taxonomy of content types" to serve as guidelines for such classification, and the attributing of inherent Guilford "content" characteristics to the subject matter examples selected was made arbitrarily. On the other hand, a study by Allen, Filep and Cooney (1967) presented evidence that subject matter content could be identified as being inherently concrete or non-concrete (abstract). The study found that motion-picture and still-graphic (pictorial) modes of visual presentation were more effective than the printed-verbal mode in the teaching of content that had concrete characteristics, but that there were no differences among the three modes in teaching content that had non-concrete characteristics. The concrete content in the cited study had similar characteristics to the figural content in the present study, and the non-concrete content was similar to the semantic content. So far as can be determined, no research has been conducted that deals with content that can be classified as having symbolic characteristics.

Intellectual Factors

Although a reasonable amount of research attention has been given to the relationships of mental ability to learning from different kinds of instructional media (Hoban and van Ormer, 1950; Allen, 1960), very little study has been made of the relationships of various intellectual abilities to the specific design characteristics of the media. Allen, Filep and Cooney (1967), using a battery of tests based on Guilford's model and selected to measure figural ability (including the "Omelet Test" of the present study), found no apparent relationship between the subjects' figural aptitude and the learning of content having different kinds of visual, audio, structural, or content inherency characteristics. Dawson (1964) obtained data to support the assumption that individuals differ in their abilities to recognize and to learn from certain graphic configurations. He reported that college students who scored high on figural portions of the Guilford-Zimmerman Aptitude Survey also were more successful in recognizing figural configurations than those who

scored low on the Survey. On the other hand, Gagne and Gropper (1964) examined individual differences of eighth graders in learning from visual and verbal presentations and found no correlations between spatial aptitude and learning with pictorial representations. However, some evidence was revealed to support the contention that higher relationships occur between verbal aptitude and learning with the verbal presentations than with the visual presentations.

In a recent paper, Snow and Salomon (1968) have reviewed some of the research on the relationships of certain aptitudes to instructional media and have made a case for the intensification of research effort in determining the extent of these relationships. However, there would appear to be little definitive evidence to date that could serve as guidelines for the design of instructional media to enhance the learning of the content by individuals with different aptitude dimensions.

CHAPTER II

METHOD AND PROCEDURES

Controlled experimentation was used to assess the effects of the variables being studied upon the learning of cognitive information having different kinds of inherent content characteristics.

Experimental Design and Method

Experimental Design

The design of the study called for the development of the nine experimental treatments described below, the administration of these treatments to experimental subjects under controlled conditions, the testing of performance of the subjects by means of posttests given immediately following exposure to the stimulus materials, and the comparison of the performance data by means of appropriate statistical techniques. Three parallel experiments were conducted, each involving subject matter content possessing different inherent characteristics: figural content on the subject of oceanography, symbolic content on the subject of the order of different kinds of happenings, and semantic content on the subject of crystallography. Subjects were 247 sixth-grade students from the Bellflower Unified School District (California), assigned at random to the different experimental treatments.

Comparisons of the performance data on each of the experiments were made by one-way analysis of variance technique for the total performance scores. Correlation analysis was used to determine the relationships between selected learner characteristics and test performance.

A posttest-only design without a control group was used, because the study was testing hypotheses concerning which of several treatments produced the greater effects and was not concerned with the question of whether the treatments were more effective than no treatment at all.

Experimental Variables

Content inherency modes. The three experiments were separately designed to include subject matter that could be characterized as possessing as inherent dominant traits one or the other of the following types of content:

1. Figural content, in which the visual material presented was high in concrete referents having depictable physical visual characteristics such as objects, things, places, or positions. The materials selected related to oceanography and depicted such things as the ecology of the sea, the movements of currents, the behavior of sea life, and the nature of the food chain in the sea. It might be expected that the learning of such content would be enhanced by the use of realistic pictorial illustrations rather than either symbolic representation or semantic explanation.

2. Symbolic content, in which the visual material presented was high in the abstract concepts and relationships where symbolic representation would be needed for comprehension. The materials selected related to the way things happen and the order in which they happen. It might be expected that the optimal mode of visual presentation of such content would be by means of symbolic representation rather than by the more realistic pictorial figural or more verbal semantic modes.

3. Semantic content, in which the visual material presented was high in content that stressed meaning or abstract ideas. The materials selected related to crystallography and depicted such abstractions as order, systems, and form. It might be expected that the optimal mode of visual presentation of such content would be by means of verbal print that stressed the meanings of the concepts rather than by the more realistic pictorial figural or symbols where meaning is not as important.

Form of presentation modes. Three different methods of presenting the visual instructional stimulus materials were designed to conform as closely as possible to Guilford's structure-of-intellect model categories (1967) in the domain that he calls "Contents," or broad classes or kinds of information involved in intellectual activities. These three forms were:

1. Figural form, in which the visual material was presented in a concrete visual form as represented by photographs and realistic drawings of the concrete aspects of the concepts being taught. The intent was to supplement the baseline audio exposition with concrete visual depiction wherever feasible.

2. Symbolic form, in which the visual material was presented in the form of symbols (including words), tokens, or signs that could be used to stand for something else and which had meaning only as they symbolized some function, concept or relationship. These symbols substituted for the concrete representational visuals used in the Figural mode and supplemented the baseline audio exposition.

3. Semantic form, in which the visual material was presented in printed verbal form (printed words and sentences) in a meaningful arrangement and where the meaning attached to the word label was important. This verbal presentation substituted for the pictures and symbols

in the other versions and supplemented the baseline audio exposition by making it more meaningful.

The presentation of all three versions was by means of projected slides, the Figural version being in realistic color, the Symbolic in color and black and white, and the Semantic in black and white print only.

Learner Variables

The combinations of the above two independent variables were studied in relation to the following learner variables:

Structure-of-intellect factors. These were intellectual factors as measured by Guilford's structure-of-intellect model (1967). They involved cognition of behavioral units and comprised three factors out of a total of 120 identified by Guilford. Cognition was defined by Guilford as "awareness, immediate discovery or rediscovery, or recognition of information in various forms: comprehension or understanding." Units were described as "relatively segregated or circumscribed items of information having 'thing' character, perhaps equivalent to the gestalt 'figure on a ground.'" The following three intellectual abilities were measured and studied:

1. Cognition of figural units, or the ability of the learner to process information in a visual form.

2. Cognition of symbolic units, or the ability of the learner to cognize symbolic units that can be used to stand for something else.

3. Cognition of semantic units, or the knowledge that the learner has of the meanings of words.

Mental ability (IQ) factors. These were intellectual factors as measured by standardized test of mental maturity.

Sex. The classification of the population as either boys or girls.

Experimental Population

The total experimental population consisted of 247 sixth-grade students (105 male and 142 female) drawn from three elementary schools in the Bellflower Unified School District (California). The subjects used comprised the total sixth-grade population of these schools, with those students eliminated who were below fourth-grade in reading ability or for whom there was no standardized test data available. The subjects were a part of the population used in a study of the motion variable in film presentation (Allen and Weintraub, 1968).

The subjects were distributed to the three experimental treatments in each of the three schools by using a table of random numbers. An analysis of variance was performed to determine if the distribution of the subjects to the experimental treatments, based upon the Lorge-Thorndike verbal IQ score and the Stanford Achievement Test scores had been random. The mean scores, standard deviations, and homogeneity of the means for these comparisons are presented in Table 1. The F values for the three analyses of variance were not significant, confirming the validity of the randomization procedure and attesting to the comparability of the treatment groups in these three learner characteristics. However, a further comparison of the experimental treatment groups on the structure-of-intellect factors showed that the randomized population was not homogenous. Table 2 shows that significant differences existed in both "Figure Completion" and "Mutilated Words" abilities among the three experimental groups.

Development of the Experimental Stimulus Materials

Nine sound slide sets were produced in accordance with the requirements of the variables being studied. The experimental visual stimulus materials were presented by means of 2" x 2" color transparency slides. The accompanying audio stimulus materials were presented by means of magnetic recording tape. These materials were combined in synchronization for presentation to the experimental treatment groups in darkened classrooms. The experimental treatments are shown in Appendix A.

Subject Matter

The subject matter for the three sets of materials consisted of three units of factual information in general science suitable for upper elementary grade students. These were units on "The Sea," on "Making Things Happen," and on "Crystallography." The basic content for each of the units was selected from the materials prepared for previously conducted experiments and modified to conform to the requirements of this experiment. "The Sea" material was used in studies by Allen, Weintraub and Cooney (1968) and Allen, Cooney and Weintraub (1968); the "Making Things Happen" material was used in a study by Allen and Cooney (1963), and the "Crystallography" material was used in a study by Allen, Filep and Cooney (1967).

The particular subject matter examples used were selected arbitrarily rather than in accordance with any clearly established criteria. There is no available taxonomy of "content types" to serve as a guideline for decision and practically no research to generalize from. Yet, the three subjects chosen do appear to satisfy the requirements of the classification scheme devised by Guilford (1967) for the kinds of material or content upon which the memory or thinking functions may

TABLE 1

MEAN SCORES, STANDARD DEVIATIONS, AND HOMOGENEITY OF MEANS FOR SELECTED LEARNER CHARACTERISTICS (ANALYSIS OF VARIANCE)

		Verbal IQ		Word Meaning		Paragraph Meaning	
	N	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ
Figural Crystallography/ Semantic MThH/ Symbolic Sea	89	100.74	12.89	53.32	14.38	55.56	16.64
Semantic Crystallography/ Symbolic MThH/ Figural Sea	78	100.37	11.69	53.46	15.15	55.72	15.76
Symbolic Crystallography/ Figural MThH/ Semantic Sea	77	101.71	12.11	54.26	13.22	57.23	15.53

	df	SS	MS	F	Prob.
VERBAL IQ					
Between Means	2	74.827	37.414	.248	NS
Within Groups	241	36290.988	150.585		
Total	243	36365.816			
WORD MEANING					
Between Means	2	41.386	20.693	.101	NS
Within Groups	241	49139.381	203.898		
Total	243	49180.766			
PARAGRAPH MEANING					
Between Means	2	135.765	67.883	.265	NS
Within Groups	241	61805.497	256.454		
Total	243	61941.262			

TABLE 2

MEAN SCORES, STANDARD DEVIATIONS, AND HOMOGENEITY OF MEANS FOR STRUCTURE-OF-INTELLECT FACTORS (ANALYSIS OF VARIANCE)

	N	Omelet		Figure Completion		Mutilated Words	
		$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ
Figural Crystallography/ Semantic MThH/ Symbolic Sea	89	4.32	2.42	17.40	4.71	8.27	3.73
Semantic Crystallography/ Symbolic MThH/ Figural Sea	78	3.62	2.17	18.00	4.75	6.40	3.13
Symbolic Crystallography/ Figural MThH/ Semantic Sea	77	3.64	2.31	19.56	4.85	7.96	3.13

	df	SS	MS	F	Prob.
OMELET					
Between Means	2	26.841	13.420	2.516	<.10
Within Groups	241	1285.471	5.334		
Total	243	1312.311			
FIGURE COMPLETION					
Between Means	2	200.177	100.089	4.403	<.05
Within Groups	241	5478.425	22.732		
Total	243	5678.602			
MUTILATED WORDS					
Between Means	2	162.581	81.291	7.194	<.001
Within Groups	241	2723.091	11.299		
Total	243	2885.672			

operate. Also, a study by Allen, Filep and Cooney (1967) presented evidence that subject matter content could be identified as being inherently "concrete" or "non-concrete."

Experimental Materials Production

For each of the three subject matter content areas scripts were prepared consisting of audio narration and accompanying visual material. In all cases, the audio narration was written so as to carry as little of the informational and instructional load as possible. The same narration was used for all three versions of the visual presentations. The three visual presentations for each experiment were developed simultaneously in order to make them as equal as possible in their presentation of the instructional content being tested.

Special artwork was prepared for the Figural and Symbolic versions, from which the slides were made. Typewriter copy was photographed as slides for the Semantic versions. All preparation of slides and audio tapes was done under the direct supervision of the research staff.

The slide material was assembled into nine Kodak Carousel slide trays and was synchronized with the audio tapes. The tapes were pulsed so as to activate the slide changes.

Measuring Instruments

Performance Tests

Three performance tests were prepared, one for each of the three subject matter areas. The tests are presented in Appendix B. "The Sea" test consisted of 29 items, the "Making Things Happen" test of 25 items, and the "Crystallography" test of 21 items. The tests consisted of multiple-choice, completion, and ordering questions and were verbal in construction. A number of test items, from the earlier studies with the same content, were used in this study either in their original form or in modified form. Additional test items were constructed to measure the cognitive information being taught.

Reliabilities of the three performance tests as determined by Kuder-Richardson Formula #20 were .588 for "The Sea," .560 for "Making Things Happen," and .515 for "Crystallography." These reliability coefficients were considered to be adequate given the length of the tests and the purpose for which they were intended.

Mental Ability and Achievement Tests

The mental ability of the subjects was measured by the Verbal Battery of the Lorge-Thorndike Intelligence Tests (Houghton Mifflin Company, 1964) as a part of the California State Testing Program. These tests measured abstract intelligence, defined as "the ability to work with ideas and relationships among ideas." Raw scores were converted into Intelligence Quotients for purposes of the analysis.

Scores on the Word Meaning and Paragraph Meaning sections of the Stanford Achievement Test (1966) were used to measure language ability. The raw scores were converted into percentile ranks for purposes of the analysis.

Structure-of-Intellect Tests

The ability of the subjects in the cognition of visual-figural units was measured by the "Figure Completion" test prepared by the Aptitudes Research Project of the University of Southern California (Guilford and Hoepfner, 1963) and the "Mutilated Words" test adapted by the Aptitudes Research Project of the University of Southern California from L. L. Thurstone's "Mutilated Words" test (Thurstone, 1944; Guilford, 1967). Guilford (1967) asserted that the "Figure Completion" test has been the "most univocal representation" of the cognition of visual-figural units factor in recent analyses, but that the "Mutilated Words" test typically shared its variance about equally between the cognition of the visual-figural units factor and the cognition of the visual-symbolic units factor. The word recognition feature of "Mutilated Words" made it in part a measure of symbolic factor, since words are symbolic units, whereas the letters could also be quite readily processed as figural units. Both tests required the recognition of either pictures or words with parts of the pictures or letters erased. The subject was required to write in the name of the object portrayed or the word when complete.

The ability of the subjects in the cognition of visual-symbolic units was measured by the so-called "Omelet" test (Guilford and Hoepfner, 1963) wherein the subject was presented with four letters and told that they could be arranged to make a word. He had to indicate the first letter of the word.

The ability of the subjects in the cognition of semantic units was measured by the Word Meaning section of the Stanford Achievement Test (1966). Guilford (1967) noted that it is the "cognition of the meaning attached to the word label, not of the label itself," that is the important factor and that the "size of the examinee's listening or reading vocabulary can be claimed as the variable measured."

Conduct of the Experiments

Schedules and procedures were worked out in detail with the administrative staff of each school and then were reviewed with the teachers of the classes involved in the experiment. At the times of the experimental runs, the subjects met in their regular classrooms and were then taken to the appropriate experimental rooms as determined by their random assignment. Subjects in the experimental rooms were given the instructions by a member of the research staff and then saw each of the three sets of subject matter content under different experimental conditions. For example, one group of subjects saw "The Sea" in the Figural form, "Making Things Happen" in the Symbolic form, and "Crystallography" in the Semantic form. After presentation of each set of materials, the lights in the room were turned on and the subjects completed the test for that material. The lights were then lowered and the second set of materials was presented and tested, followed by the third set of materials and test. The entire procedure consumed about 75 minutes of time.

Preparation of Data and Statistical Analysis

Responses to the performance test items were made directly on the tests themselves. After scoring, they were transferred to sense-score sheets for mechanical transfer to IBM cards.

One-way analyses of variance were undertaken to identify the characteristics of the population and to establish the statistical differences among the experimental variables. The analysis of variance computer program used was the "Summary Program," furnishing t-test and one-way analysis of variance analyses (Computer Sciences Laboratory, 1967).

Product moment coefficients of correlation were obtained between all learner characteristics and performance test scores and compared for each experiment by means of χ^2 test for independent correlations which used the z transformations of the correlations (Edwards, 1960).

All statistical analyses were made on the Honeywell 800 computer, operated by the staff of the Computer Sciences Laboratory, University of Southern California.

CHAPTER III

RESULTS

Test results were analyzed for each of the experiments separately. The analyses included comparison of results on the total performance tests by means of analysis of variance and correlations between selected learner characteristics and test performance. In addition, comparisons were made of responses to each test item separately.

Analysis of Total Performance

The mean test performance scores and the results of the one-way analyses of variance for the three experiments are presented in Table 3.

Significant differences among the three treatment groups were found in the first experiment only, "The Sea," which dealt with subject matter content of Figural Inherency. The Semantic form of visual presentation (18.61) was superior to the Symbolic form (17.06) at the .02 level and to the Figural form (17.33) at the .10 level of significance as determined by t-test.

There were no significant differences among the treatment groups in either the second experiment, "Making Things Happen," which dealt with subject matter content of Symbolic Inherency or in the third experiment, "Crystallography," which dealt with subject matter content of Semantic Inherency.

Analysis by Learner Characteristics

The relationships of the various learner characteristics to scores on the performance tests are presented in Table 4. The product moment correlation coefficients were obtained with performance test scores as the dependent variable and each learner characteristic as the independent variable. The significance of the differences among the correlations for each of the learner characteristics in each of the three experiments are presented in Table 5.

Sex

The sex of the subjects was found to have no significant relationship to performance except for a small superiority for the girls on the Symbolic and Semantic treatment modes of "The Sea." There was

TABLE 3

COMPARISONS OF TOTAL TEST PERFORMANCE BY ANALYSIS OF VARIANCE

	N	$\bar{X}$	σ
1. "THE SEA" (Figural Inherency)			
Figural	78	17.33	4.03
Symbolic	88	17.06	3.59
Semantic	56	18.61	3.36
2. "MAKING THINGS HAPPEN" (Symbolic Inherency)			
Figural	79	17.47	3.02
Symbolic	51	17.18	3.14
Semantic	90	17.50	3.07
3. "CRYSTALLOGRAPHY (Semantic Inherency)			
Figural	89	9.33	2.96
Symbolic	79	9.80	2.69
Semantic	78	9.46	3.27

	df	SS	MS	F	Prob.
1. "THE SEA"					
Between Means	2	87.643	43.822	3.206	< .05
Within Groups	219	2993.406	13.669		
Total	221	3081.050			
2. "MAKING THINGS HAPPEN"					
Between Means	2	3.776	1.888	.201	NS
Within Groups	217	2041.583	9.408		
Total	219	2045.359			
3. "CRYSTALLOGRAPHY"					
Between Means	2	9.704	4.852	.546	NS
Within Groups	243	2157.695	8.879		
Total	245	2167.398			

TABLE 4

CORRELATION COEFFICIENTS BETWEEN LEARNER CHARACTERISTICS AND PERFORMANCE TEST SCORES

	THE SEA (Figural Inherency)			MAKING THINGS HAPPEN (Symbolic Inherency)			CRYSTALLOGRAPHY (Semantic Inherency)		
	Figural (N=77)	Symbolic (N=86)	Semantic (N=55)	Figural (N=76)	Symbolic (N=50)	Semantic (N=89)	Figural (N=88)	Symbolic (N=76)	Semantic (N=78)
Sex	-.086	-.240**	-.294**	.063	.249	.072	-.122	-.223	-.019
Word Meaning	.629*	.567*	.565*	.571*	.405*	.365*	.428*	.457*	.567*
Paragraph Meaning	.578*	.557*	.610*	.519*	.321**	.413*	.515*	.400*	.543*
IQ	.563*	.551*	.578*	.506*	.404*	.455*	.533*	.513*	.523*
Figure Completion	.073	.198	.313**	.188	.158	.191	.107	.038	.120
Mutilated Words	.188	.270**	.389*	.152	.099	.197	.161	.163	.127
Total F-C and M-W	.161	.274**	.437*	.222**	.172	.235**	.157	.098	.132
Omelet	.196	.082	.211	.164	.181	-.013	.034	.312*	.058

*$p < .01$

**$p < .05$

TABLE 5

COMPARISON OF INDEPENDENT CORRELATIONS BY χ^2 TEST
(2 degrees of freedom)

	THE SEA (Figural Inherency)		MAKING THINGS HAPPEN (Symbolic Inherency)		CRYSTALLOGRAPHY (Semantic Inherency)	
	χ^2	Prob.	χ^2	Prob.	χ^2	Prob.
Sex	1.568	< .50	1.310		1.798	< .50
Word Meaning	.412		3.070	< .30	1.368	
Paragraph Meaning	.950		1.758	< .50	1.278	
IQ	.086		.409		.000	
Figure Completion	2.860	< .30	.008		.199	
Mutilated Words	1.334		.254		.000	
Total F-C and M-W	2.750	< .30	.103		.068	
Omelet	.469		1.691	< .50	3.864	< .20

no significant superiority for any of the three treatment modes as a function of the sex of the subjects, as determined by the X^2 test for independent correlations.

Academic Language Achievement

The academic language achievement factors (Word and Paragraph Meaning) were significantly related to performance in all three experiments, the correlations ranging from .321 to .629. However, there was no significant superiority for any of the treatment modes as determined by the X^2 test for independent correlations. The only comparison approaching significance ($< .30$) was the Word Meaning factor for the "Making Things Happen" experiment, wherein the correlation for the Figural treatment mode was .571 as compared to .405 for the Symbolic mode and .365 for the Semantic mode.

Mental Ability

The mental ability level (IQ) of the subject was also found to be significantly related to performance in all three experiments, the correlations ranging from .404 to .578. However, there was no significant superiority for any of the treatment modes as determined by the X^2 test for independent correlations.

Structure-of-Intellect Factors

The structure-of-intellect factors varied in their relationships to performance.

Cognition of visual-figural units. The visual-figural factor was significantly related to performance in only the Semantic treatment mode of "The Sea" for the Figure Completion test and in only the Semantic and Symbolic modes of "The Sea" for the Mutilated Words test. When the totals for both tests were used, these same two treatment modes showed significant correlations, as did the Figural and Semantic treatment modes for "Making Things Happen." Only the Figure Completion test and the total of both tests approached significance ($< .30$), the correlations showing a superiority for the Semantic mode and an inferiority for the Figural mode.

Cognition of visual-symbolic units. The visual-symbolic factor (Omelet test) was significantly related to performance in only the Symbolic treatment mode of "Crystallography." However, this test most closely approached significance ($< .20$) of any of the comparisons, the Symbolic treatment mode being superior to the other two modes.

Cognition of semantic units. If Word Meaning (also discussed above as an Academic Achievement factor) test score can be considered

a measure of cognition of semantic units, this factor was found to be significantly related to performance in all three experiments. However, when the correlations of the three treatment groups were compared, the differences approached significance (< .30) only in the "Making Things Happen" experiment, the Figural treatment mode being superior to the other two treatment modes.

Analysis of Specific Test Items

The mean test performance scores on each of the items in the three tests were compared by means of analysis of variance. Where significant differences were found, comparisons between treatment groups were made by t-test. These results are summarized in Table 6, showing an analysis of the specific differences among the groups and a description of the characteristics of the visuals where significant differences in performance were found. The means for the treatment modes, the significance of the differences among them, and the t-test comparisons for each of the test items are presented in Appendix C (Table 7).

Of the 75 items on the three tests combined a total of 28 items (37.3%) were significant at the .05 level or lower. The greatest number of significant differences was found for "The Sea" experiment (figural inherency), 55.2%, and the least number for the "Making Things Happen" experiment (symbolic inherency), 20%. The "Crystallography" experiment (semantic inherency) showed 33.3% of significant differences. When the differences between the three different visual presentation modes were determined by t-test, a total of 43 significant differences were found. These differences predominantly favored the Semantic treatment mode, this mode being superior in 23 cases (53.5%), the Symbolic mode in 11 cases (25.6%) and the Figural mode in 9 cases (20.9%). It should be noted that there was no apparent relationship between the "content inherency" characteristics assigned to the subject matter and the nature of the visual presentation modes. That is, the Semantic visual presentation mode was superior for content having either Figural or Symbolic subject matter content inherency, and the Semantic and Symbolic visual presentation modes were about equal in the number of significant items with content having Semantic inherency. It appeared that other factors than subject matter content inherency were operating as contributors to the learning of the material.

When the visual presenting the content to be learned for the test items showing significant differences were analyzed, one dominant visual characteristic was apparent. This was the importance of very explicit similarity between the specific content of the visuals and the responses elicited in the test questions. Table 6 shows that 28 of the 43 significant differences (65.1%) could be attributed to this stimulus generalization factor. Three examples are presented in order to point up the nature of this stimulus-test similarity.[1]

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[1]Other comparisons may be made by combining the content from Appendices A, B, and C.

TABLE 6

SUMMARY ANALYSIS OF TEST ITEMS RESULTING IN SIGNIFICANT DIFFERENCES BETWEEN TREATMENT MODES

	Total Items in Test	Items with Significant Differences	Total t-test Differences ($p < .05$)	Characteristics of Differences Between Visuals			
				Stimulus/ Test Differences	Confusion with other Visuals	Opposite to Cue in Stimulus	No Explanation
"THE SEA" (Figural Inherency)	29	16	(25)	(17)	(4)	(0)	(4)
Figural Superior			6	4			2
Symbolic Superior			5	2	1		2
Semantic Superior			14	11	3		
"MAKING THINGS HAPPEN" (Symbolic Inherency)	25	5	(6)	(2)	(0)	(0)	(4)
Figural Superior			1				1
Symbolic Superior			1				1
Semantic Superior			4	2			2
"CRYSTALLOGRAPHY" (Semantic Inherency)	21	7	(12)	(9)	(0)	(1)	(2)
Figural Superior			2	1		1	
Symbolic Superior			5	4			1
Semantic Superior			5	4			1
TOTAL	75	28	(43)	(28)	(4)	(1)	(10)
Figural Superior			9	5	0	1	3
Symbolic Superior			11	6	1	0	4
Semantic Superior			23	17	3	0	3

Example A (Figure 1) showed a very significant advantage ($p < .001$) to the Figural and Symbolic treatment modes over the Semantic mode. The test question asked for the temperature near the bottom of the sea. It may be observed that both the Figural and Symbolic treatment modes presented this information in the actual figures (33°) required as a correct response. The Semantic mode, on the other hand, did not give the actual "33°" figure but required the subject to extrapolate the answer from the givens, "35 degrees" and "drops only 2 degrees."

Example B (Figure 2) showed a significant advantage to the other two treatments, more so to the Figural than to the Symbolic. The test question asked which color light rays went deepest into the sea. The Semantic version furnished the specific information necessary to answer the question. The information was not contained in the Figural version (although an examination of Frame 5 and 6 of "The Sea" script in Appendix A will show that the color bands were displayed as visual stimuli), and the information was in the Symbolic version only implicitly.

A similar condition exists in Example C (Figure 3) in which the Semantic and Symbolic treatments were both significantly superior to the Figural. The test question required the subject to write in the name of solids that did not have internal order ("amorphous"). This information was given in both the superior treatments, but was carried only in the narration accompanying the Figural mode. It is interesting to note that none of the subjects in the Figural group answered the question correctly.

A second characteristic was identified in one section of "The Sea" experiment. This has been labelled: "Confusion with other Visual" and may have resulted from an incorrect association with an activity. The test questions asked for a determination of which activities took place in the food chain. The responses "fish eat the chemicals (#17c) and "fish eat the bacteria" (#17e) were incorrect. The Figural group, in each case achieved significantly lower performance than the Semantic group. This could have been caused by the presentation of a picture of a fish eating plankton, which could have been confused with chemicals in the picture. This confusion was not present in the other versions.

The one case where the results may have demonstrated a contrary finding to the stimulus-test similarity tendency reported above occurred on Question No. 2 of the "Crystallography" experiment. This question asked the subject to "name a well-known crystal shown in the slides." The Figural version showed a salt shaker inscribed with the letter "S" and with particles pouring from it. The Symbolic version showed a slide with "Salt Crystals" printed on it, and the Semantic version used the phrase, "common as salt." One might expect that the actual word "salt" in the Symbolic and Semantic versions would cue the correct response. As a matter of fact, the Figural version resulted in the most significant learning.

Stimulus Content:

25. "There is a difference of only two degrees from the top to the bottom of the dark area." ("The Sea")

Figural	Symbolic	Semantic
	35°	At the top of the dark part of the sea, the temperature is always about 35 degrees.
	33°	It drops only 2 degrees in going all the way down to the ocean floor.

Test Question:

3. The temperature near the bottom of the sea is about

a. 33 degrees
b. 35 degrees
c. 55 degrees
d. 70 degrees

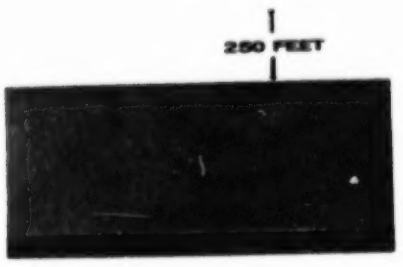
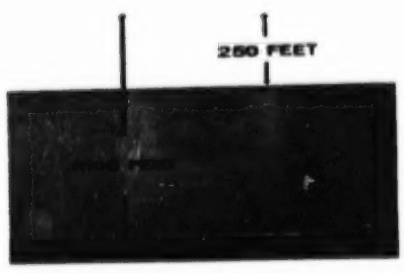
Test Performance Analysis (Question No. 3):

Mode	Mean	Analysis of Variance	t-test Comparisons
Figural	.756	F = 19.199 p < .001	Figural/Semantic p < .001 Symbolic/Semantic p < .001
Symbolic	.625		
Semantic	.268		

Figure 1. Example A: Stimulus-Test Similarity

Stimulus Content:

7. "These rays reach down into the sea." ("The Sea")

Figural	Symbolic	Semantic
		The warm rays ... Red, Orange and Yellow ... reach into the sea only 250 feet.
		But the cool rays ... Green, Blue and Violet ... reach deeper into the sea, up to about 1500 feet.

Test Question:

8. Which color light rays go down deepest into the sea?

green, blue, violet, etc. (cool color)
(write in)

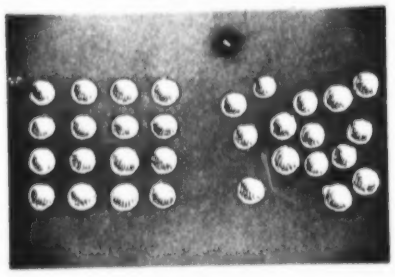
Test Performance Analysis (Question No. 8):

Mode	Mean	Analysis of Variance	t-test Comparisons
Figural	.218	$F = 11.669$	Semantic/Figural $p < .001$
Symbolic	.352	$p < .001$	Semantic/Symbolic $p < .01$
Semantic	.607		

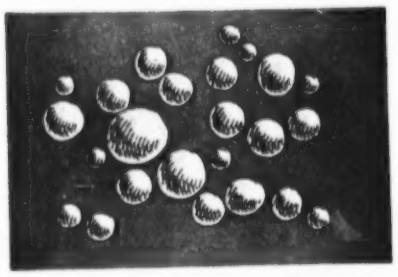
Figure 2. Example B: Stimulus-Test Similarity

Stimulus Content:

9. "But crystals are different from many other solids." ("Crystallography")

Figural	Symbolic	Semantic
	**ORDER** **vs.** **NO ORDER**	Crystals differ from other solids in the way the atoms are arranged. Orderly in crystals... not orderly in other solids.

10. "Solids which are unlike crystals are called amorphous solids."

	**= AMORPHOUS**	The other solids are called amorphous solids. Their atoms are arranged in a mixed-up way.

Test Question

7. Solids which do not have internal order are called

amorphous (write in) solids.

Test Performance Analysis (Question No. 7):

Mode	Mean	Analysis of Variance	t-test Comparisons
Figural	.000	$F = 5.785$ $p < .005$	Symbolic/Figural $p < .001$ Semantic/Figural $p < .01$
Symbolic	.127		
Semantic	.090		

Figure 3. Example C: Stimulus-Test Similarity

There were eleven cases where significant differences among the treatments were found, but where no explanation for such differences could be determined.

CHAPTER IV

CONCLUSIONS, DISCUSSION, AND IMPLICATIONS

This chapter will present the specific conclusions that may be derived from the data, discuss the results of the study, and suggest implications of the study for the design of instructional media.

Conclusions

The following conclusions may be made from an analysis of the results of the study:

1. The Semantic form of visual presentation, which presented the content in a meaningful printed verbal form, resulted in statistically significant learning superiority over the Figural and Symbolic forms of presentation for "The Sea" (figural inherency) experiment only. No significant differences were found in the "Making Things Happen" (symbolic inherency) and "Crystallography" (semantic inherency) experiments.

2. The sex of the subjects was found to have no significant relationship to test performance or to the mode of visual presentation used.

3. The language ability factors of the subjects were significantly related to test performance, but were unrelated to the mode of visual presentation used.

4. The mental ability level of the subjects was significantly related to test performance, but was unrelated to the mode of visual presentation used.

5. The structure-of-intellect factors showed no consistent relationships to test performance nor to the mode of visual presentation used.

6. There was no apparent relationship between the "content inherency" characteristics assigned to the subject matter and the nature of the visual presentation modes.

7. The analysis of individual test items revealed that significant differences among the three treatment groups favored the Semantic mode of visual presentation in 53.5% of the cases.

8. The major reason for the differences in performance among the treatment groups could be attributed to the similarity between the specific content of the visuals and the responses elicited in the test questions, a total of 65.1% of the significant differences on individual test items being accountable by this characteristic.

9. In summary, the feasibility of using the Guilford structure-of-intellect model as a device to guide the design and production of instructional materials--either in the design of the form of visual presentation, in the attribution of characteristics to the subject matter content, or in the characteristics of the learners--was not confirmed by the results of the study.

Discussion

Mode of Visual Presentation

The fact that no consistent significant differences were found among the effects of the visual presentation modes for the three experiments suggests that (1) the form of presentation, as form, was not a crucial factor in affecting learning, or that (2) other factors than presentational form were operating.

Given the cognitive nature of the educational task performed by the subject--that is, the recall of specific verbal information presented in the stimuli--it is, perhaps, not too surprising to find that the form of visual presentation was not a critical factor in learning the subject matter content. Careful attention was given, in the preparation of the stimuli, to include in each treatment mode all the cues necessary to learn the content. When these specific cues appeared in each of the three treatment mode presentations and when they were specifically tested, there was no apparent difference in learning them. Both Hoban and van Ormer (1950) and Allen (1960) drew similar conclusions from the earlier media research.

As discussed above in Chapter I, little or no research attention has been given to the different types of forms that might be taken by a particular instructional message presented by means of a particular medium (in this case, the sound slide). It would appear, on the basis of the results of this study, that the design of such media in a form dictated by Guilford's structure-of-intellect model is not feasible. That is, that Guilford's model, devised to account for the various intellectual abilities of individuals, does not operate as a factor in identifying different kinds of media forms that would serve as variables in learning from the media. It is always possible, of course, that, in the translation of the Guilford model to the different media forms, the characteristics of the model were not faithfully interpreted in the materials. However, every effort was made to conform to the definitions of the model insofar as a cognitive verbal model can be converted into a visual form, and it is believed that the resultant experimental treat-

ments rather closely approximated the intent of the original Guilford model.

Because two of the visual presentation forms--figural and semantic--correspond to the two most common subdivisions of stimuli--nonverbal and verbal--the findings of the study may have implications beyond those related to the Guilford model itself. The results suggest at least that, for the learning of cognitive verbal factual information when the facts to be learned are presented explicitly in each visual presentation treatment, the form of presentation (verbal or nonverbal) is not a critical variable to the learning of the information. The fact that the symbolic treatment--which combined elements from both the other treatments in that it had some figural characteristics and used verbal word symbols--also showed similar results, tends to support this conclusion. Such a conclusion, however, needs further confirmation by means of research and by analysis of some of the specific results of past research.

Inherency of the Content

One of the purposes of this study was to investigate the relationships of the mode of visual presentation employed and the characteristics of the learners to the inherent characteristics of the subject matter content. The assumption was made that content has certain characteristics that may be inherent in that particular type of content. Consequently, content was selected for learning that presumably possessed subject matter that could be described as being inherently figural, symbolic, or semantic in nature. The prediction was made that the visual presentation group which was consonant with the inherent nature of the content would perform on the criterion tests at a significantly higher level than the other groups. This prediction was not supported by the findings from the research.

Assuming that the inherent content characteristics were correctly attributed, there appeared to be no reason to believe that a relationship existed between content characteristics and the mode of visual presentation. As a matter of fact, the superiority of the semantic visual presentation mode with material having figural inherency characteristics ("The Sea") was opposite to the predicted direction. This finding was contrary to that of Allen, Filep and Cooney (1967), in which they found a positive relationship between figural presentation modes (motion picture and still picture) and material with "concrete" inherency characteristics. This study and the earlier one cited used the same criteria in selecting the "figural" and "concrete" subject matter, but the earlier study used the visuals to supplement printed verbal content. Thus, they are not totally comparable. The lack of differences on content having "symbolic" and "semantic" characteristics in this study and in content having "nonconcrete" inherency in the Allen, Filep and Cooney study do tend to be supporting. However, given the absence of other research that might contribute to a solution of this problem, a final conclusion must be withheld.

Characteristics of Learners

The negative findings on the relationships between the different learner characteristics studied and the mode of visual presentation employed support the findings from previous research in some cases and contradict them in others.

Although there were no consistent relationships between sex of the subjects and performance on the different visual presentation treatments, there appeared to be some experiment-to-experiment differences that bear further attention. The significant relationship between sex and performance on the symbolic and semantic treatments of "The Sea" (figural inherency), favoring the girls, and the nonsignificant advantage to the boys on "Making Things Happen" (symbolic inherency) and to the girls on "Crystallography" (semantic inherency) suggest that there were sex-related subject matter differences. It is difficult, however, to determine just what these differences are. The boys apparently did better on stimulus higher in symbolic content, and the girls did better on the more concrete and meaningful content.

The fact that the mental ability of the subjects was related to performance on the criterion tests but unrelated to mode of visual presentation conforms to the general findings from previous research. On the other hand, Gropper (1966) had found a significant relationship between IQ and mode of presentation, the higher ability subjects profiting more from the verbal presentation than from the visual presentation and the lower ability subjects profiting more from the visual presentation.

The overall lack of significant relationships of the structure-of-intellect factors with either the mode of visual presentation or with the inherent characteristics of the subject matter content further supports the general findings throughout the study that these factors are not a viable influence in the design of instructional media. As pointed out in Chapter I, both Gagne and Gropper (1964) and Allen, Filep and Cooney (1967) found no correlations between figural aptitude and learning from stimuli having different types of visual characteristics. This does not mean, of course, that some kind of "figural" aptitude is absent as a differential characteristic in individual learners. Rather, the particular traits measured in this study were found to be inoperative for this population of subjects. It should be noted that the structure-of-intellect tests used were not designed for use with subjects in elementary school, and the difficulty level of the tests may have been a contributing factor leading to this lack of relationship. Regardless of the reason, however, it would appear that factors other than these would need to be looked to as indicators of learner response to different types of visual presentation.

Stimulus-Test Similarity

The discovery of the importance of the similarity between the specific content of the visuals of all modes and the responses elicited in the test questions, as determined from an analysis of specific test questions, was the major positive finding from the study. In the literature, this principle has been called "stimulus generalization" and has been stated by Hartman (1961) to mean that "learning of presented information increases as the testing situation becomes more similar to the presentation situation." A clear confirmation of this principle was obtained in the present study.

The operation of stimulus generalization overrode any influence that other factors may have exercised. This happened in 65 percent of the instances where the individual test items showed significant differences among the different visual presentation modes, and it was found to operate for all three of the visual presentation modes. It should be noted that the criterion tests were verbal tests of cognitive factual information, and it was just this type of informational content that resulted in significant learning. When the verbal cues--words or numbers--appeared in the stimulus, and when these same cues appeared and were elicited in the tests, they were recalled more often than when such cues either did not appear in the stimuli or were presented in an altered form.

Implications

The implications of this study for the design or selection of instructional media seem to be more negative than positive. That is, the predicted interactions among visual presentation mode, content characteristics, and learner characteristics were not obtained. This does not mean, of course, that such variables are not important in the design of instructional media, but that, under the conditions prevailing in this study, they did not produce the expected effects. Two implications may be drawn from the study, however:

1. The nature of the instructional objective being served by the instructional presentation may be of critical importance in selecting the mode of visual presentation to be employed. This study concerned itself with the learning of cognitive verbal factual information, and it was found that such learning could be equally enhanced by either verbal or nonverbal visual stimuli when all the crucial cues to be learned were included in the alternate visual modes of presentation. Thus, it may be implied that the mode of still (nonmotion) visual presentation of material is not an important factor in teaching verbal factual information.

2. The stimulus material should be designed to conform as closely as possible to the task to be performed in the criterion situation. For the learning from material presenting cognitive factual information appears to be very specific to the actual facts presented.

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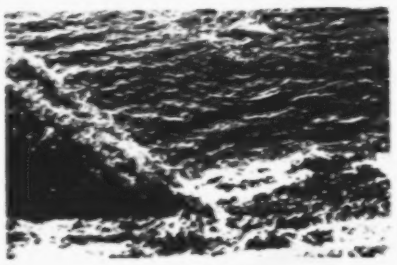
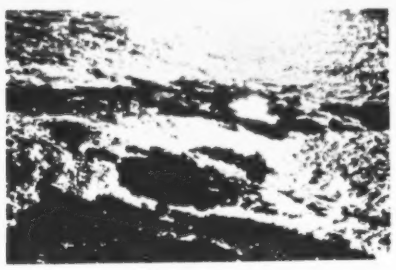
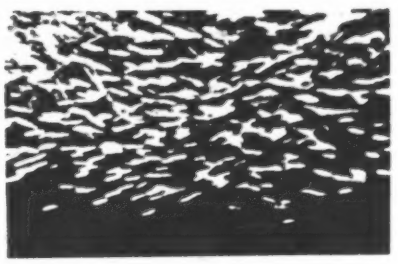
APPENDIX A

SCRIPTS OF EXPERIMENTAL TREATMENTS

EXPLANATION: The complete scripts for each of the three treatment modes for each of the three subject matter content areas are presented below. Following the number, the audio narration is given. The duration in seconds for the accompanying visuals follows in parentheses. Then the three alternate visual presentation modes are presented: Figural, Symbolic, and Semantic.

"THE SEA" (6 minutes 30 seconds)

	Figural	Symbolic	Semantic
1. These slides will tell about the sea ... (7 seconds)		SEA	Think about the sea and how it covers much of our earth.
2. ... about the light on the sea ... (4.5 seconds)		SUN SEA	The light on the sea comes from the sun.
3. ... and under the sea. (6 seconds)		SUN SEA	Some of this light reaches down into the sea.

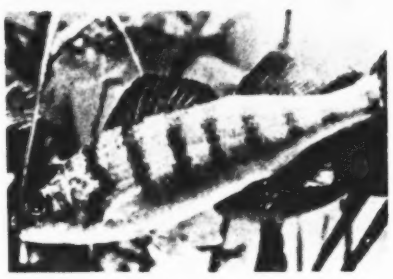
Figural | Symbolic | Semantic

4. You will learn that light has to do with plant life and animal life in the sea. (9 seconds)

LIGHT

PLANT GROWTH

The light in the sea helps plants to grow.

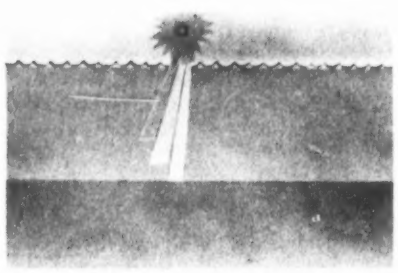


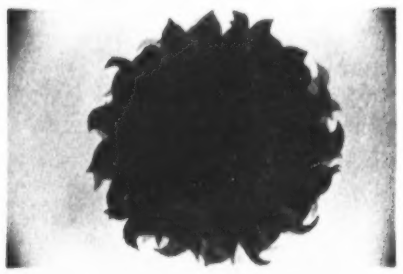
LIGHT

ANIMAL GROWTH

This light also helps animals to grow.

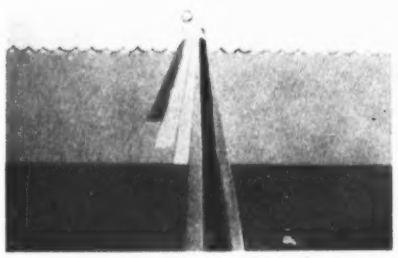
5. Light reaches the sea in warm ways ... (7 seconds)

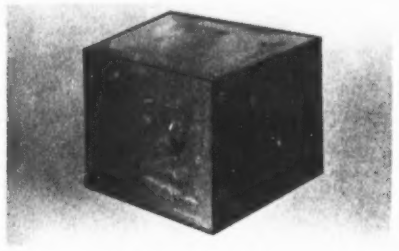




Light enters the sea in warm rays which are Red, Yellow and Orange.

6. ... and in cool rays. (7 seconds)

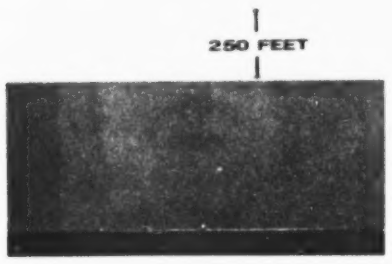


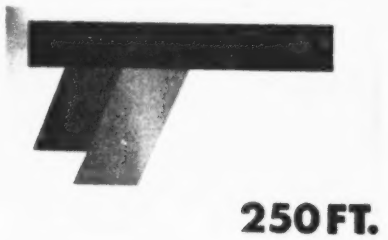


Light also enters the sea in cool rays which are Green, Blue and Violet.

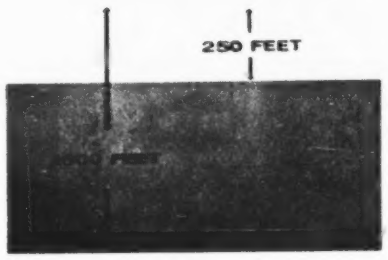
Figural	Symbolic	Semantic

7. These rays reach down into the sea. (22 seconds)





The warm rays ... Red, Orange and Yellow ... reach into the sea only 250 feet.



But the cool rays ... Green, Blue and Violet ... reach deeper into the sea, up to about 1500 feet.

8. Everything below is dark and cold. (8 seconds)

Below this the sea is dark and cold because no light reaches down to warm it.

9. Light is important to safety in the sea. (12 seconds)

LIGHT = SAFETY

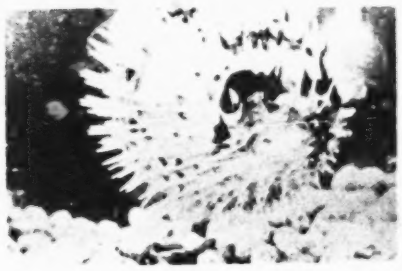
Light helps sea life to stay safe.

DARKNESS = SAFETY

When enemies see them, fish may blend into the light above or the darkness below.

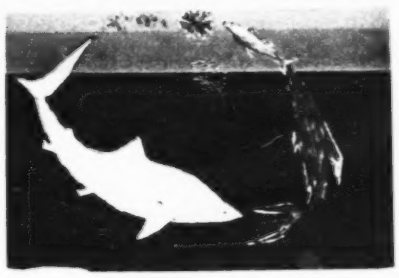
Figural | Symbolic | Semantic

10. Nature has camouflaged sea life to look like its surroundings. (3 seconds)



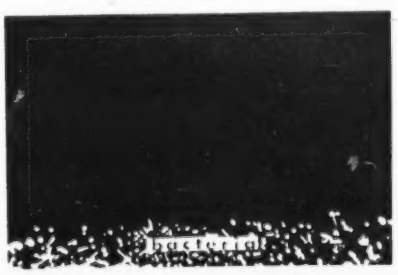
They also blend into their surroundings.

11. There is a food-chain in the sea--one form of life feeding on another form of life. (11 seconds)



All sea life needs food. Big fish eat little fish; and they are eaten by even bigger fish. This way of life is called a food chain.

12. This food-chain begins with bacteria from decayed matter on the ocean floor. (6 seconds)

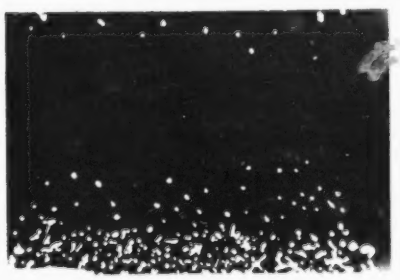


BACTERIA

DECAYED MATTER

Plants and animals decay on the bottom of the sea. Bacteria are formed.

13. Bacteria makes chemicals ... (5 seconds)



CHEMICALS

The bacteria make chemicals which rise up through the water.

Figural	Symbolic	Semantic

14. ... which become food ... (6 seconds)

PLANTS

These chemicals become food for tiny plants floating on the top of the sea.

15. ... through a process called photosynthesis (8 seconds)

PHOTOSYNTHESIS

Photosynthesis happens when the right amounts of light and chemicals are present.

16. It happens in millions of tiny plants, feeding millions of tiny animals. Both these plants and animals are called plankton. (9 seconds)

PLANKTON

Such tiny plants and animals are called plankton. Plankton soak up the chemicals for food.

17. You may wonder what makes the chemicals rise from deep in the sea. (5.5 seconds)

?

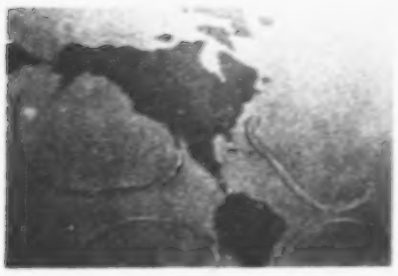
Why do chemicals rise from the bottom of the sea to become food?

Figural | Symbolic | Semantic

18. The water is always in motion ... (3 seconds)

Everywhere the sea keeps moving.

19. ... pushed by the winds ... (6 seconds)



Winds push the warm water away from the equator toward the cold poles.

20. ... sinking ... (5 seconds)

The warm water grows cool and sinks to the bottom of the sea.

21. ... flowing back ... (5.5 seconds)

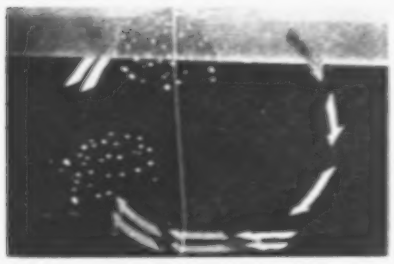
It flows back toward the equator along the bottom of the sea.

Figural	Symbolic	Semantic

22. ... and rising ... (7 seconds)

Then it rises to replace the warm water which has moved away from the equator.

23. ... bringing up the chemicals. (6 seconds)



It is at this time that the water from below brings up the chemicals.

24. Yet the upward motion of these chemicals in the water can be stopped. Stopped by changes in the temperatures of the sea. (6 seconds)

But the upward motion of the water and chemicals can be stopped.

25. There is a difference of only 2° from the top to the bottom of the dark area. (15 seconds)

35°

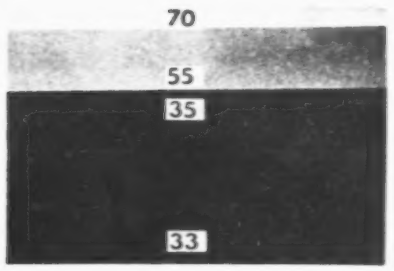
At the top of the dark part of the sea, the temperature is always about 35 degrees.

33°

It drops only 2 degrees in going all the way down to the ocean floor.

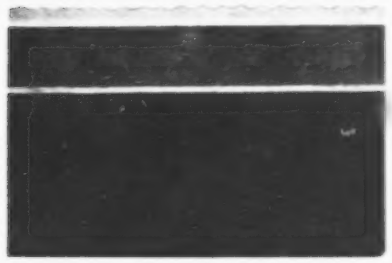
Figural | Symbolic | Semantic

26. But the greatest change happens at the surface. (8 seconds)



But temperatures on the surface of the sea change greatly from season to season.

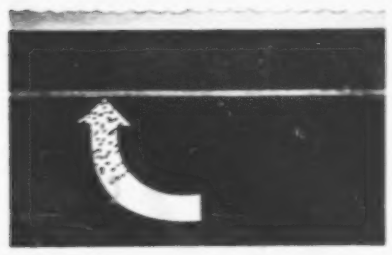
27. The point where the greatest change in temperature begins is called a thermocline. (13 seconds)

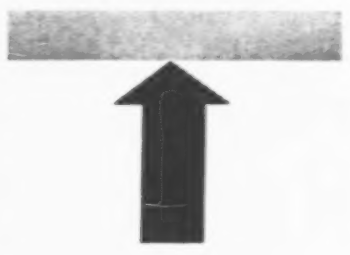


THERMOCLINE

Above the dark part of the sea, summer temperatures may be quite high.
The point of greatest change in temperature is called a thermocline.

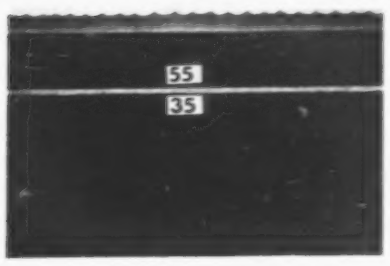
28. In summer this thermocline acts like a wall. (9 seconds)



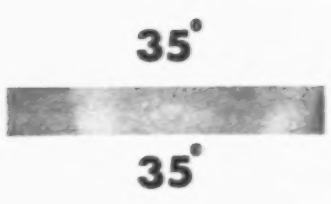


In summer this thermocline is like a wall -- it stops the upward motion of water and chemicals.

29. But in winter the temperatures change. (15 seconds)



The temperature above the thermocline is much greater than the temperature below the thermocline.



But winter temperatures above and below the dark part of the sea may be alike.

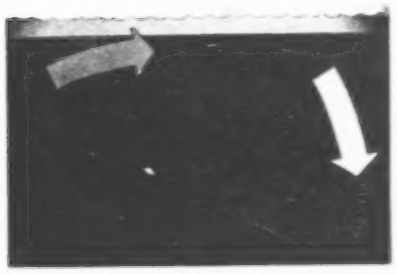
Figural	Symbolic	Semantic

30. Then the wall disappears. (4 seconds)

35°
35°

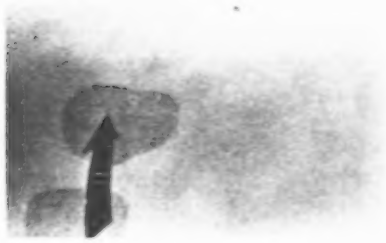
Then the wall, or thermocline, disappears.

31. The upward motion of the sea also changes. (5 seconds)



The upward flow of the water goes all the way to the top.

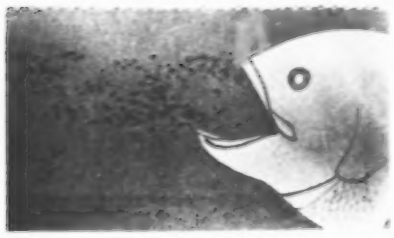
32. And so does the rise of chemicals ... (6 seconds)



CHEMICALS

Then the chemicals move up freely from the bottom to the top of the sea.

33. ... to make food in the sea. (8 seconds)



And food is provided for all sea life through the chain.

"MAKING THINGS HAPPEN" (4 minutes 23 seconds)

Figural	Symbolic	Semantic

1. Here are some slides about making things happen in an orderly way. (4 seconds)

1	2	3

Things can be made to happen step by step.

2. In the home ... (6 seconds)

1. PLAN
2. COOK } BREAKFAST
3. EAT

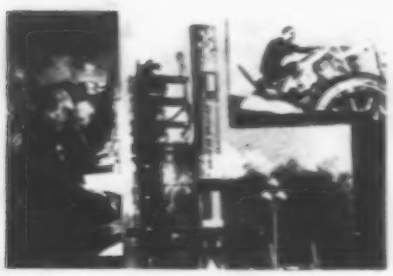
Breakfast is planned.
Then it is cooked.
Then it is eaten.

3. ... outside the home ... (6 seconds)

1. PLAN
2. GO } CAR TRIP
3. ARRIVE

We get ready for a trip.
We take the trip.
We arrive at our goal.

4. ... in national affairs ... (7 seconds)



1. PLAN
2. GO } SPACE FLIGHT
3. RETURN

Prepare space capsule to launch.
It is launched.
It returns to earth.

Figural | Symbolic | Semantic

5. It takes planning ... (5 seconds)

1	2	3

We plan each step to happen in an orderly way.

6. ... to control happenings. (4 seconds)

1 ⟶ 2 ⟶ 3

The happenings flow in a planned way.

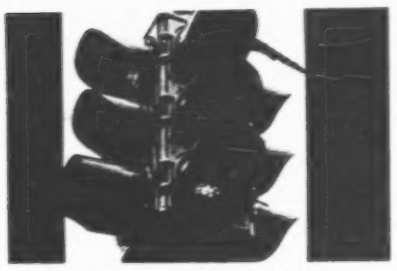
7. We call the steps by which things happen a sequence. (5 seconds)

1 ⟶ 2 ⟶ 3

SEQUENCE

This orderly flow is called a sequence of happenings.

8. If we try, we can make any sequence orderly. (5 seconds)



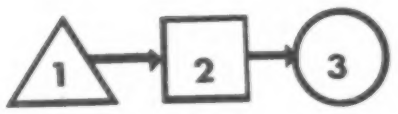
1 ⟶ 2 ⟶ 3

4 ⟶ 5 ⟶ 6

In a planned sequence things happen in the right order.

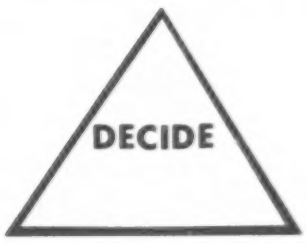
Figural Symbolic Semantic

9. There are major steps to any sequence. (5 seconds)



Try to remember the three basic steps in a sequence.

10. First, we choose what to do. (7 seconds)



First, we make a decision ... like Mother choosing what to cook for breakfast.

11. Next, we follow through on what we decided to do. (5 seconds)

Secondly, we act ... like Mother cooking breakfast.

12. Finally, we finish what we set out to do. (6 seconds)

Thirdly, we complete the action ... like eating breakfast.

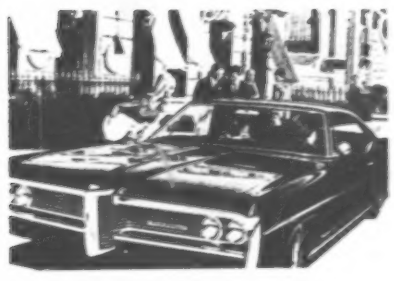
Figural	Symbolic	Semantic

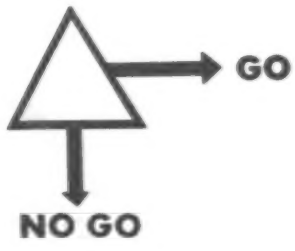
13. Let's look at another sort of happening. (4 seconds)

CAR RIDE

Here is what happens when we go for a car ride.

14. First, we make a choice. (3 seconds)





Shall we go?

or

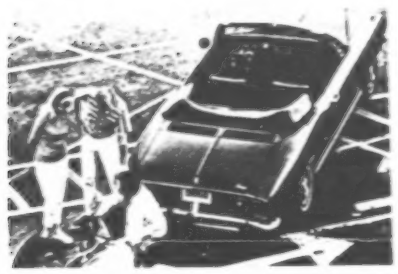
Shall we not go?

15. Having chosen, we go into action. (3 seconds)

GOING

We go on the ride.

16. Finally, we finish what we set out to do. (3.5 seconds)

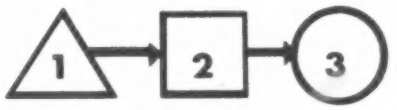


END

We arrive at the end of our ride.

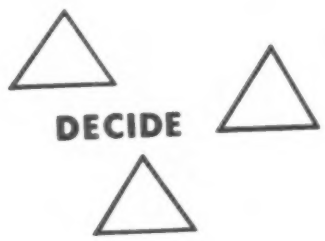
Figural Symbolic Semantic

17. We planned, we did, and we finished what we chose to do. (5 seconds)



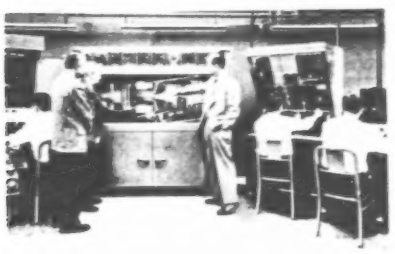
This was a sequence of happenings ... each step flowed in order.

18. Sometimes we must make many choices ... all at once, or one after another. (3.5 seconds)



We must consider all possible choices.

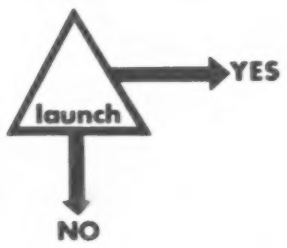
19. Such complex planning and action are found in the work of space engineers. (5 seconds)



PLANNING

This kind of planning is done when we send up an astronaut.

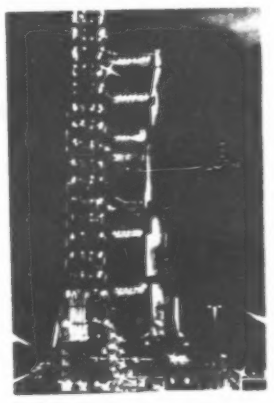
20. Again, the first step is to make a choice. (4 seconds)

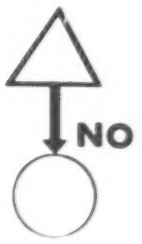


Do we launch the rocket?
or
Do we wait?

Figural | Symbolic | Semantic

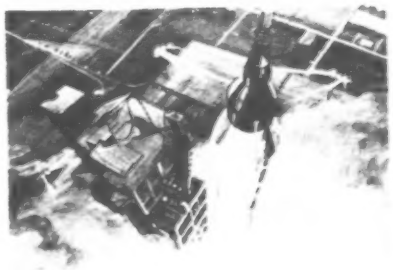
21. If the choice is to wait, the action stops. (4 seconds)

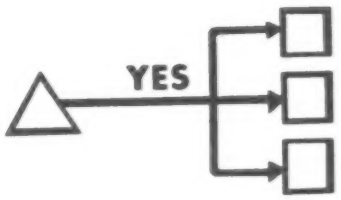




If we choose to wait, no rocket will be launched.

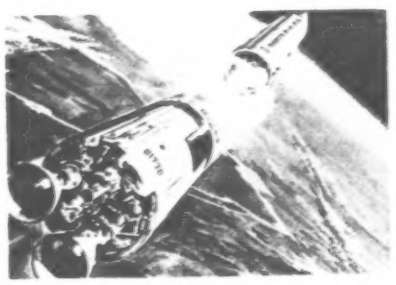
22. But, if the choice is to go ahead, many things happen. (8 seconds)

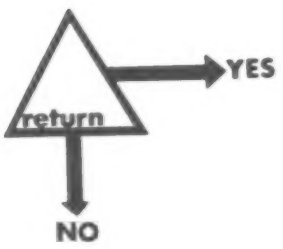




But if we choose to go, many different actions must take place at just the right time.

23. New decisions follow the first action. (7 seconds)

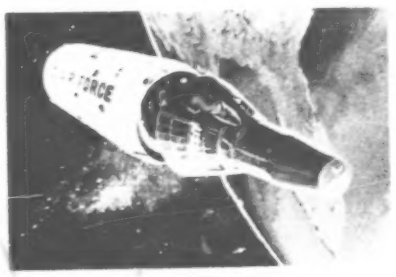




Once the rocket is launched, new decisions must be made...such as,

Should we return to earth?

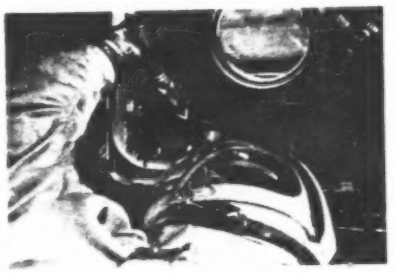
24. The choice may be to wait. (5 seconds)

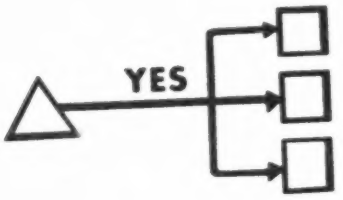


If the choice is to wait, the rocket continues to circle the earth.

Figural | Symbolic | Semantic

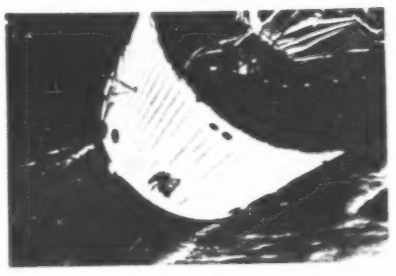
25. If the choice is to end, a new sequence takes place. (5 seconds)





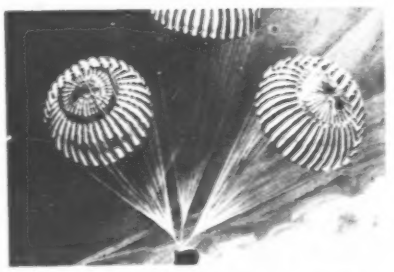
Again, many things happen in the right order, at the right time.

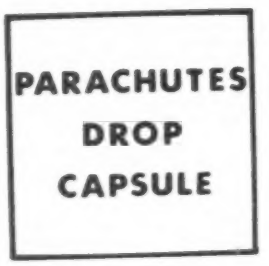
26. The first step is taken ... (4 seconds)



Return rockets push the capsule toward the earth.

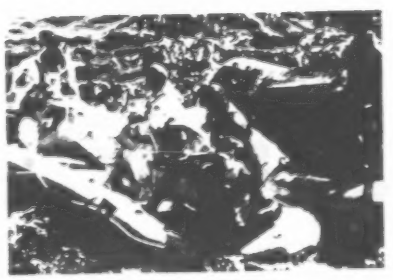
27. The second ... (4.5 seconds)





Slow-down parachutes drop the capsule gently toward the earth.

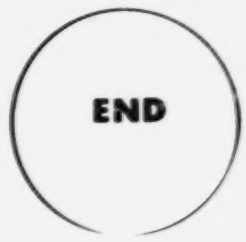
28. And the third. (4 seconds)



Recovery teams rescue astronaut from water.

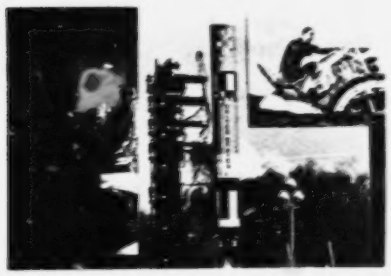
Figural	Symbolic	Semantic

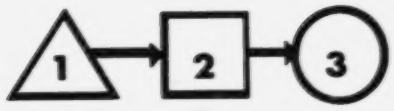
29. Finally, all the action ends. (3 seconds)



The rocket's flight has been completed.

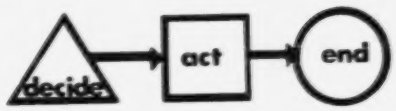
30. You have seen that there was a planned order to what happened. (5 seconds)





In whatever happened, there was a plan, an order, a sequence.

31. Everything in sequence ... making the right choices, taking the right action. (6 seconds)



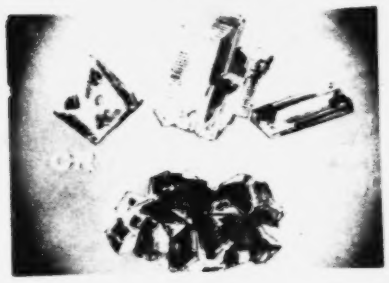
A decision was made.

An action was taken.

That action was completed.

"CRYSTALLOGRAPHY" (4 minutes)

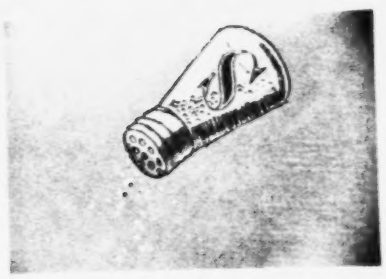
1. You will now see some slides about crystals and crystallography. (6 seconds)



CRYSTALLOGRAPHY

Crystallography means the study of crystals in their different forms.

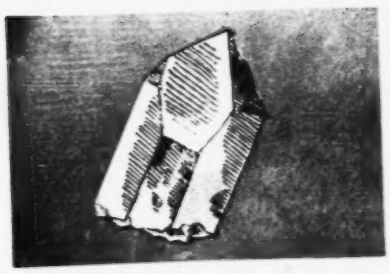
2. Some crystals are well-known to you. (4 seconds)



SALT CRYSTALS

Crystals can be as common as salt . . .

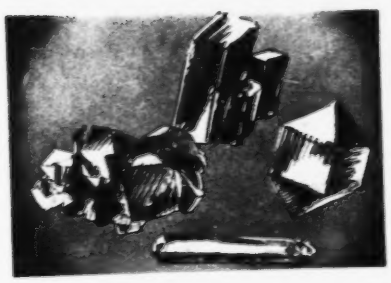
3. Some may be less familiar. (8 seconds)



QUARTZ CRYSTALS

Or they may be less common, like quartz crystals formed from molten rock.

4. But all crystals are alike in some ways. (8 seconds)

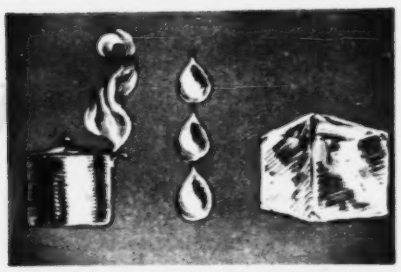


QUARTZ
SALT
EMERALDS
OTHERS
CRYSTALS

Quartz, salt, emeralds and other crystals resemble each other in some ways.

Figural	Symbolic	Semantic

5. All belong to one of the important forms of matter. (5 seconds)

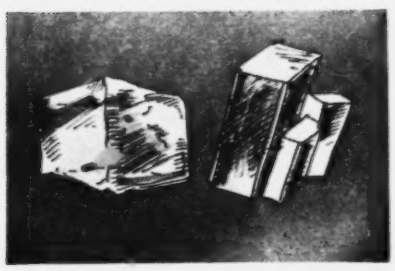


GAS
LIQUID
SOLID

There are three forms of matter:

Gases, Liquids, Solids.

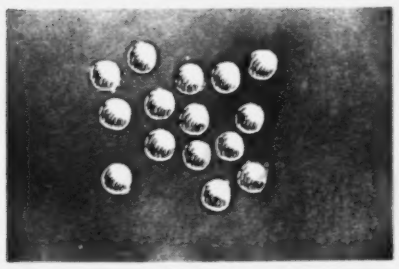
6. We are concerned with only one of these forms of matter. (4 seconds)



CRYSTAL = SOLID

A crystal is a solid form of matter.

7. All forms of matter are made up of tiny atoms. (6 seconds)

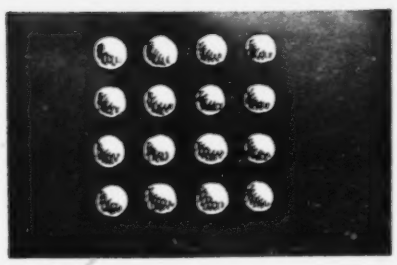


atom
atom atom
atom atom
atom
atom atom
atom
atom

= MATTER

Atoms are like tiny building blocks which make up each form of matter.

8. This is also true of crystals. (6 seconds)



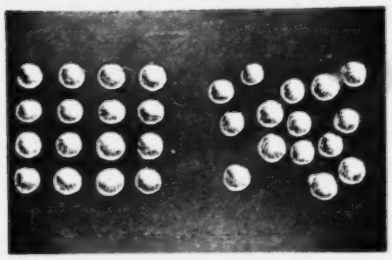
atom atom atom
atom atom atom
atom atom atom
atom atom atom

= ORDER

In crystals, the atoms form in a definite and regular order.

Figural	Symbolic	Semantic

9. But crystals are different from many other solids. (10 seconds)



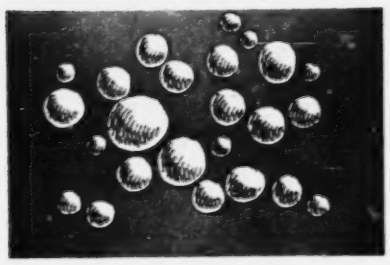
ORDER

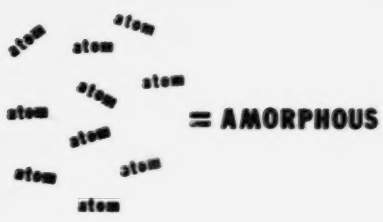
VS.

NO ORDER

Crystals differ from other solids in the way the atoms are arranged. Orderly in crystals... not orderly in other solids.

10. Solids which are unlike crystals are called amorphous solids. (7 seconds)



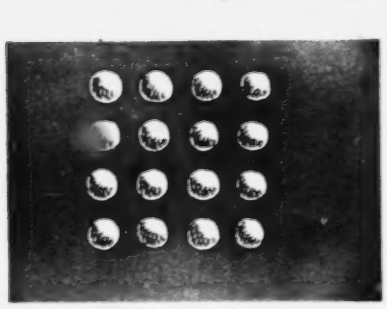


= AMORPHOUS

The other solids are called amorphous solids.

Their atoms are arranged in a mixed-up way.

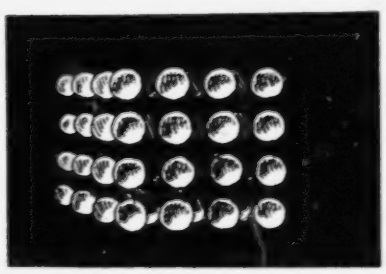
11. We shall be concerned here with only the first of these two solids. (8 seconds)



CRYSTAL = ORDER

Crystallography deals only with solids whose atoms are arranged in orderly patterns.

12. First, let's talk about the internal order or structure of crystals. (7 seconds)

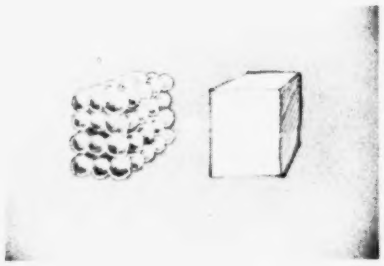


STRUCTURE

The order of the atoms within a crystal determines its structure.

Figural	Symbolic	Semantic

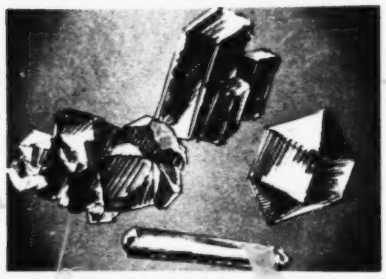
13. The internal order that decides how crystals look to us! (6 seconds)



INTERNAL STRUCTURE ➡ SHAPE

This internal structure gives a crystal its outward shape.

14. Crystals differ. (6 seconds)



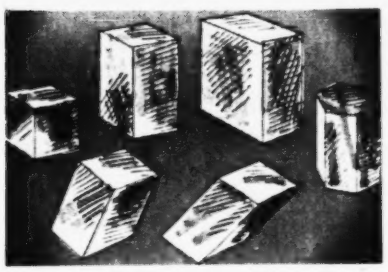
SHAPE

SHAPE

SHAPE

Crystals of different substances have different shapes.

15. Crystals can be grouped according to their shapes. (5 seconds)

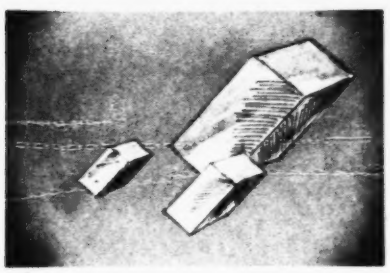


1 2 3

4 5 6

Crystals can be grouped according to six different shapes.

16. Each group is called a system. (13 seconds)



SYSTEM

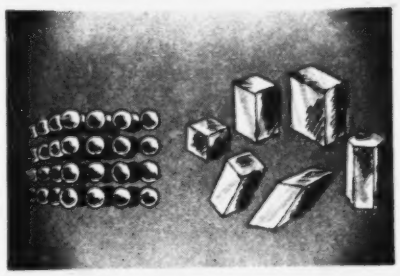
SYSTEM

SYSTEM

Each group of crystal shapes is called a system.
In any one system, the crystals may have different sizes and colors but only one shape.

Figural	Symbolic	Semantic

17. We now have looked at two of the three most important ideas about crystallography. (7 seconds)

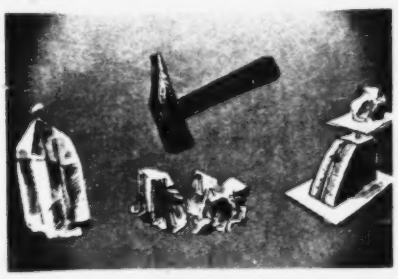


1. STRUCTURE

2. SYSTEM

Structure and Systems are two important parts of our study of crystallography.

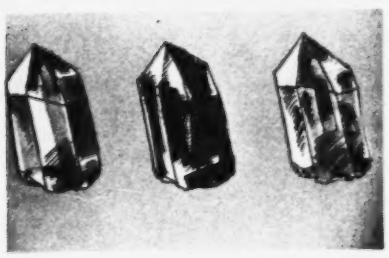
18. Let's look at the third idea: the different properties of crystals. (12 seconds)



COLOR
HARDNESS — **PROPERTIES**
WEIGHT

Crystallography also deals with the properties of crystals. These are physical qualities, like color, hardness and weight.

19. For instance, different colors ... (6 seconds)



Crystals may be very different in color yet have the same shape.

Figural	Symbolic	Semantic

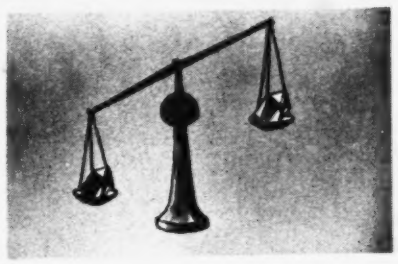
20. ... or different hardness ... (9 seconds)

SOFT
MEDIUM
HARD

Crystals also differ widely in hardness --

Some are very soft...
Some are very hard...
Some are in-between.

21. ... or different weights. (4 seconds)

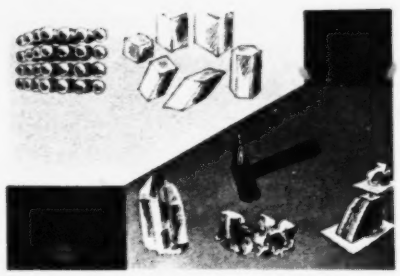


LIGHT

HEAVY

Crystals also differ in weight.

22. So we have given thought to three important ideas about crystals (8 seconds)



1. STRUCTURES

2. SYSTEMS

3. PROPERTIES

There are three key ideas for defining crystallography:

Structure, Systems, Properties.

APPENDIX B

PERFORMANCE TESTS

NOTE: The correct answers are indicated in the Performance Tests by underlining in the case of the multiple-choice items or by the insertion of the acceptable answers for the constructed responses.

"THE SEA"

1. Which of the following best describes the way in which sunlight goes down into the sea?

   a. warm rays may be found near the top
   b. warm rays go down deeper than cool rays
   c. only the cool rays go all the way to the bottom
   d. both warm and cool rays go down to the bottom

2. The process used by plants to produce food from chemicals and light is called photosynthesis.

3. The temperature near the bottom of the sea is about

   a. 33 degrees
   b. 35 degrees
   c. 55 degrees
   d. 70 degrees

4. Tiny living plants and animals found near the surface of the sea are called

   a. bacteria
   b. plants
   c. plankton
   d. fish

5. The difference between the temperature at the top and the temperature at the bottom of the sea is

   a. greatest in the summer, least in the winter
   b. least in the summer, greatest in the winter
   c. greatest in the fall, least in the spring
   d. least in the fall, greatest in the spring

6. Most of the warm water of the sea moves toward the

a. North and South poles
b. shores in North and South America
c. equator
d. thermocline

7. The bacteria from dead animals and plants are found

a. at the thermocline in the sea
b. in the dimly lit area of the sea
c. in the parts of the sea with the most light
d. at the bottom of the sea

8. Which color light rays go down deepest into the sea?

violet; blue; blue-violet; dim blue; dark blue; dark purple; purple; ultraviolet (has to be a cold color)

9. In the profile of the sea shown below, one temperature is not correct. Choose the temperature that would correct this error.

a. 35 should be 38 — 70
b. 55 should be 60 — 55
c. 22 should be 33 — 35
d. 70 should be 75 — 22

10. Plants of the sea and grass of the earth are both found near the surface because

a. they both need chemicals
b. they both need light
c. they are safest there
d. they both have roots

11. Plants use _____ to make their food.

a. plankton
b. chemicals
c. fish
d. bacteria

12. In the deepest parts of the sea, the water temperature

a. is always low
b. changes with the weather
c. changes with the seasons
d. is the highest near the equator

13. In clear water, the warm rays of the sun go down about _____ into the sea.

a. 7 miles
b. 150 feet
c. 250 feet
d. 850 feet

14. The chemicals used by plants in photosynthesis come from the

a. plankton in the top layer
b. plants on the bottom
c. dead fish in the middle
d. bacteria on the bottom

15. Most of the sea is

a. dim
b. light
c. dark
d. very dark

) either is correct

16. Plankton are

a. fish
b. plants only
c. animals only
d. both plants and animals

17. Which of the items below take place in the food chain? (There may be more than one answer to this question.)

a. fish hide in plants
b. fish swim toward the light
c. fish eat the chemicals
d. fish swim toward the poles for food
e. fish eat the bacteria
f. fish eat plankton
g. fish eat other fish

18. Which of the following best describes the movement of the sea?

a. the wind cools the sea and the water sinks
b. cool water moves toward the poles and rises to be warmed
c. the sea moves up and down with the winds and back and forth with the seasons
d. warm water moves toward the poles, sinks and moves back to be warmed

19. In what ways do fish find safety? (There may be more than one answer here.)

a. they stay out of the food chain
b. they blend into their background
c. they swim fast
d. they blend into the thermocline
e. they blend into the darkness

"MAKING THINGS HAPPEN"

1. What do we call the steps by which things happen?

sequence

2. If you were going on a round trip to the beach from your home, how would you classify coming out of the water?

a. completing
b. deciding
c. doing
d. choosing

3. All sequences of events can be put into _____ major steps.

a. two
b. three
c. four
d. as many as you want

4. How does planning of the kind shown in the slides help avoid errors?

a. it shows us that all problems are difficult
b. it makes decisions for us
c. it helps us check each step in an orderly way
d. it faces us with complicated problems

5. What three kinds of things take place in any sequence of happenings?

a. choosing, completing, and deciding
b. doing, finishing, and sequencing
c. choosing, preparing, and eating
d. doing, deciding, and completing

6. Which of the following things could not be shown as a sequence of happenings. (There may be more than one answer to this question.)

a. going on an airplane ride
b. getting ready for school
c. pushing a button to fire a rocket
d. making a model airplane
e. an airplane
f. deciding what to eat

7. Which of the following is the best sequence of happenings for going camping?

a. plan to go camping, pack the car, return home
b. decide to go, pack the car, go camping
c. planning, preparing, doing
d. decide to go camping, go camping, return home

8. To solve complicated problems, we have to

a. make things happen in a step-by-step way
b. make complicated answers
c. make decisions very quickly
d. make things happen very quickly

9. How would you classify deciding what to wear?

a. wearing a coat
b. taking the coat out of the closet
c. completing
d. choosing

10. Here is a list of things that happen when you go camping. Put them in the right order by placing a number in the space in front of each happening.

3 put up the tent
5 take down the tent
1 decide to go camping
4 camp over night
6 return home
2 plan which highways you will take

11. In the following sequence of happenings, draw a circle around the things that could happen at the same time

a. turning the fire off
b. turning the fire on
c. putting the pan on the stove
d. deciding whether or not the water is boiling
e. filling a pan with water

"CRYSTALLOGRAPHY"

1. All matter is made up of tiny particles called

   a. crystals
   b. gases
   c. molecules
   d. atoms

2. Name of well-known crystal shown in the slides

   salt

3. If you wanted to classify some crystals in their proper system, what would you look for?

   a. their size
   b. their physical properties
   c. their shape
   d. their atoms

4. Which is more like the atoms in a crystal?

   a. a school of fish
   b. recess
   c. children playing tag
   d. men marching

5. Circle the letter in front of the items which could be properties of crystals. (There may be more than one answer.)

   a. the shape
   b. number of atoms
   c. its heaviness
   d. its softness
   e. blue color
   f. its size
   g. internal structure

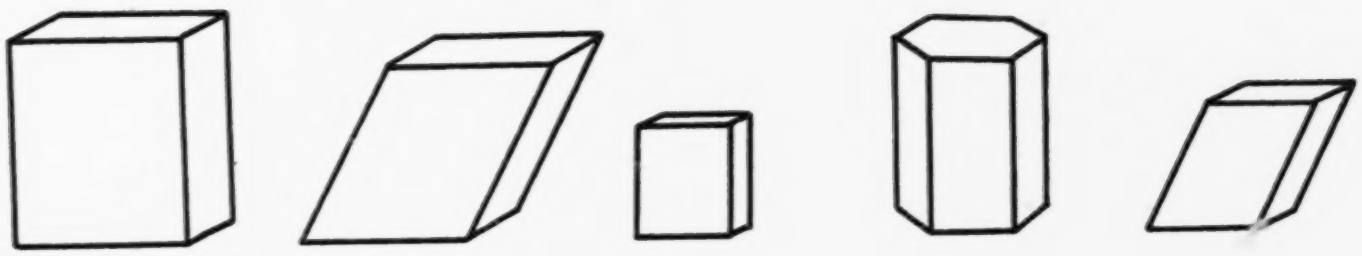
6. Brick is to wall as _____ is to crystal.

   a. salt
   b. atom
   c. color
   d. ice

7. Solids which do not have internal order are called _____ solids

   amorphous

8. Suppose that you had five crystals and they looked like this:



How many different crystal systems would you put them in?

a. 2
b. 3
c. 4
d. 5

9. Crystals are forms of matter that

a. have internal order
b. have no internal order
c. sometimes have internal order
d. none of these

10. If two crystals have the same shape

a. they have the same properties
b. they are made of the same atoms
c. they belong to the same system
d. all of these

11. How many crystal systems are recognized in the study of crystals?

a. 1
b. 2
c. 6
d. 12
e. there is no limit

12. What decides the shape of a crystal?

a. the structure of the crystal
b. whether it is amorphous or not
c. its physical properties
d. the kind of atoms the crystal contains

13. What determines the structure of a crystal?

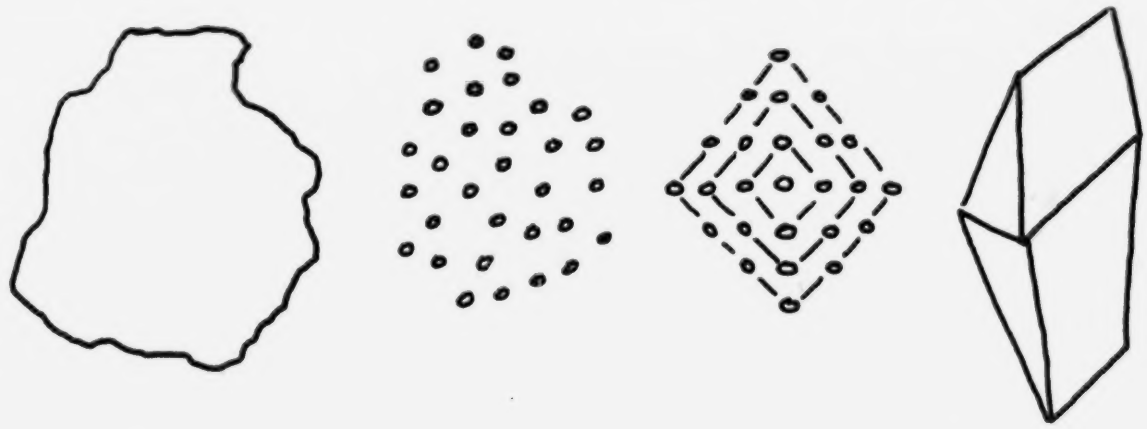
a. the way its atoms are arranged
b. whether or not it is a solid
c. its properties
c. its shape

14. A crystal is a

a. gas
b. solid
c. liquid
d. none of these

15. Which of the following pictures is most like the internal structure of a crystal?

(a) (b) (c) (d)



APPENDIX C

TABLE 7

PERFORMANCE ON INDIVIDUAL TEST ITEMS BY TREATMENT GROUPS

	Presentation Mode	$\bar{X}$	Analysis of Var. df	F	Prob.	t-test Comparisons
"THE SEA" (Figural Inherency)						
#1	Fig*	.295	2/219	3.360	<.05	Sem/Sym.05**
	Sym	.227				
	Sem	.429				
#2	Fig	.333	2/219	.384	--	
	Sym	.273				
	Sem	.286				
#3	Fig	.756	2/219	19.199	<.001	Fig/Sem.001;Fig/Sym.10;Sym/Sem.001
	Sym	.625				
	Sem	.268				
#4	Fig	.526	2/219	4.596	<.025	Sym/Fig.02;Sem/Fig.01
	Sym	.705				
	Sem	.750				
#5	Fig	.731	2/219	.160	--	
	Sym	.693				
	Sem	.696				
#6	Fig	.192	2/219	3.411	<.05	Sem/Fig.02;Sem/Sym.10
	Sym	.261				
	Sem	.393				
#7	Fig	.692	2/219	5.131	<.01	Fig/Sym.01;Fig/Sem.02
	Sym	.466				
	Sem	.482				
#8	Fig	.218	2/219	11.669	<.001	Sym/Fig.10;Sem/Fig.001;Sem/Sym.01
	Sym	.352				
	Sem	.607				

*Fig = Figural treatment; Sym = Symbolic treatment; Sem = Semantic treatment.

**This should be read: "The Semantic treatment was superior to the Symbolic treatment at the .05 level of significance as compared by t-test."

TABLE 7--Continued

	Presentation Mode	$\bar{X}$	Analysis of Var. df	F	Prob.	t-test Comparisons
#9	Fig Sym Sem	.667 .420 .536	2/219	5.208	<.01	Fig/Sym.01
#10	Fig Sym Sem	.705 .659 .750	2/219	.680	--	
#11	Fig Sym Sem	.359 .477 .589	2/219	3.595	<.05	Sem/Fig.01
#12	Fig Sym Sem	.615 .523 .518	2/219	.912	--	
#13	Fig Sym Sem	.667 .636 .679	2/219	.155	--	
#14	Fig Sym Sem	.692 .420 .607	2/219	6.818	<.005	Fig/Sym.001;Sem/Sym.05
#15	Fig Sym Sem	.436 .511 .554	2/219	.972	---	
#16	Fig Sym Sem	.756 .852 .679	2/219	3.120	<.05	Sym/Sem.02
#17a	Fig Sym Sem	.859 .773 .821	2/219	1.026	--	
#17b	Fig Sym Sem	.846 .864 .839	2/219	.092	--	
#17c	Fig Sym Sem	.513 .602 .714	2/219	2.789	<.10	Sem/Fig.02

TABLE 7--Continued

	Presentation Mode	$\bar{X}$	Analysis of Var. df	F	Prob.	t-test Comparisons
#17d	Fig	.897	2/219	2.172	--	
	Sym	.795				
	Sem	.893				
#17e	Fig	.436	2/219	15.011	<.001	Sem/Fig.001;Sem/Sym.05;Sym/Fig.01
	Sym	.693				
	Sem	.857				
#17f	Fig	.423	2/219	5.711	<.005	Sym/Sem.01
	Sym	.580				
	Sem	.304				
#17g	Fig	.821	2/219	6.182	<.005	Fig/Sym.02;Sem/Sym.01
	Sym	.648				
	Sem	.875				
#18	Fig	.218	2/219	5.076	<.01	Sem/Fig.01;Sem/Sym.01
	Sym	.239				
	Sem	.446				
#19a	Fig	.821	2/219	.465	--	
	Sym	.864				
	Sem	.875				
#19b	Fig	.769	2/219	2.221	--	
	Sym	.727				
	Sem	.875				
#19c	Fig	.654	2/219	2.307	<.10	Sem/Fig.10;Sem/Sym.05
	Sym	.648				
	Sem	.804				
#19d	Fig	.859	2/219	.495	--	
	Sym	.807				
	Sem	.804				
#19e	Fig	.577	2/219	1.852	--	
	Sym	.716				
	Sem	.679				

TABLE 7--Continued

	Presentation Mode	$\bar{X}$	Analysis of Var. df	F	Prob.	t-test Comparisons
"MAKING THINGS HAPPEN (Symbolic Inherency)						
#1	Fig	.620	2/217	2.539	<.10	Sem/Fig.05
	Sym	.686				
	Sem	.778				
#2	Fig	.329	2/217	.364		
	Sym	.314				
	Sem	.378				
#3	Fig	.747	2/217	.770	--	
	Sym	.824				
	Sem	.733				
#4	Fig	.810	2/217	1.347	--	
	Sym	.824				
	Sem	.722				
#5	Fig	.430	2/217	4.688	<.01	Fig/Sem.01;Sym/Sem.02
	Sym	.431				
	Sem	.233				
#6a	Fig	.848	2/217	.882	--	
	Sym	.804				
	Sem	.767				
#6b	Fig	.696	2/217	.007	--	
	Sym	.706				
	Sem	.700				
#6c	Fig	.684	2/217	2.250	--	
	Sym	.686				
	Sem	.544				
#6d	Fig	.759	2/217	.751	--	
	Sym	.686				
	Sem	.778				
#6e	Fig	.658	2/217	.346	--	
	Sym	.588				
	Sem	.644				
#6f	Fig	.266	2/217	1.860	--	
	Sym	.314				
	Sem	.178				
#7	Fig	.392	2/217	.609	--	
	Sym	.490				
	Sem	.422				

TABLE 7--Continued

	Presentation Mode	$\bar{X}$	Analysis of Var. df	F	Prob.	t-test Comparisons
#8	Fig	.899	2/217	1.472	--	
	Sym	.843				
	Sem	.933				
#9	Fig	.823	2/217	4.287	<.025	Sem/Sym.01;Sem/Fig.10
	Sym	.725				
	Sem	.911				
#10a	Fig	.886	2/217	.367	--	
	Sym	.843				
	Sem	.844				
#10b	Fig	.949	2/217	.379	--	
	Sym	.922				
	Sem	.956				
#10c	Fig	.886	2/217	2.875	<.10	Sem/Fig.02
	Sym	.922				
	Sem	.978				
#10d	Fig	.861	2/217	.642	--	
	Sym	.784				
	Sem	.822				
#10e	Fig	.962	2/217	.025	--	
	Sym	.961				
	Sem	.956				
#10f	Fig	.861	2/217	2.443	<.10	Sem/Fig.05
	Sym	.922				
	Sem	.956				
#11a	Fig	.785	2/217	1.292	--	
	Sym	.706				
	Sem	.822				
#11b	Fig	.468	2/217	.179	--	
	Sym	.510				
	Sem	.511				
#11c	Fig	.481	2/217	1.103	--	
	Sym	.392				
	Sem	.522				
#11d	Fig	.595	2/217	.630	--	
	Sym	.627				
	Sem	.678				
#11e	Fig	.772	2/217	.874	--	
	Sym	.667				
	Sem	.733				

TABLE 7--Continued

	Presentation Mode	$\bar{X}$	Analysis of Var. df	F	Prob.	t-test Comparisons
"CRYSTALLOGRAPHY" (Semantic Inherency)						
#1	Fig	.697	2/243	2.510	<.10	Sym/Fig.10;Sym/Sem.05
	Sym	.823				
	Sem	.679				
#2	Fig	.764	2/243	15.104	<.001	Fig/Sem.001;Fig/Sym.10;Sym/Sem.01
	Sym	.633				
	Sem	.372				
#3	Fig	.427	2/243	7.093	<.001	Fig/Sym.001;Sem/Sym.05
	Sym	.165				
	Sem	.321				
#4	Fig	.517	2/243	.432	--	
	Sym	.506				
	Sem	.449				
#5a	Fig	.303	2/243	.560	--	
	Sym	.278				
	Sem	.231				
#5b	Fig	.551	2/243	4.685	<.01	Sym/Fig.02;Sem/Fig.02
	Sym	.734				
	Sem	.744				
#5c	Fig	.573	2/243	.626	--	
	Sym	.633				
	Sem	.654				
#5d	Fig	.281	2/243	8.112	<.001	Sym/Fig.01;Sem/Fig.001
	Sym	.506				
	Sem	.564				
#5e	Fig	.753	2/243	.575		
	Sym	.772				
	Sem	.821				

TABLE 7--Continued

	Presentation Mode	$\bar{X}$	Analysis of Var. df	F	Prob.	t-test Comparisons
#5f	Fig	.449	2/243	.400	--	
	Sym	.494				
	Sem	.423				
#5g	Fig	.517	2/243	1.232	--	
	Sym	.519				
	Sem	.410				
#6	Fig	.438	2/243	.069	--	
	Sym	.430				
	Sem	.410				
#7	Fig	.000	2/243	5.785	<.005	Sym/Fig.001;Sem/Fig.01
	Sym	.127				
	Sem	.090				
#8	Fig	.371	2/243	.091	--	
	Sym	.367				
	Sem	.397				
#9	Fig	.506	2/243	.035	--	
	Sym	.519				
	Sem	.526				
#10	Fig	.427	2/243	.775	--	
	Sym	.342				
	Sem	.423				
#11	Fig	.045	2/243	5.556	<.005	Sem/Fig.01;Sem/Sym.10
	Sym	.101				
	Sem	.205				
#12	Fig	.292	2/243	.395	--	
	Sym	.354				
	Sem	.308				
#13	Fig	.506	2/243	1.087	--	
	Sym	.392				
	Sem	.462				
#14	Fig	.708	2/243	1.494	--	
	Sym	.810				
	Sem	.705				
#15	Fig	.202	2/243	.963	--	
	Sym	.291				
	Sem	.269				